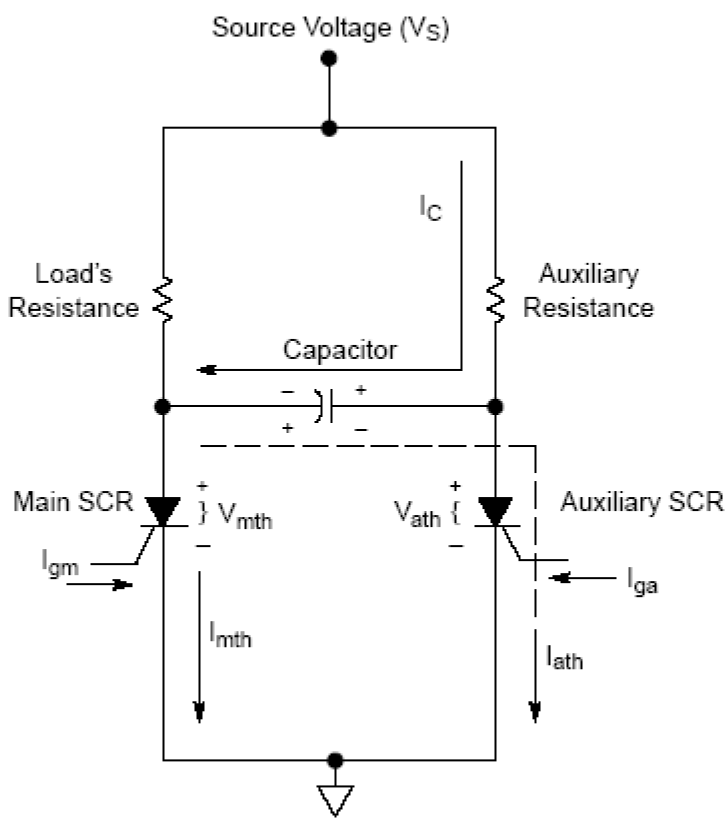
Taisan Solenoid Pump Circuit

Forced Commutation Methods for Turning–Off the SCRs
As known, when a thyristor or silicon controlled rectifier (SCR) device is used in D.C. applications, once it is triggered, it is going to be latched no matter if its I_{gt} signal is removed from its gate terminal, and it will remain in its on–state whenever the current flowing through its main terminals is higher than its I_H (holding current). In order to cause a successful turn–off condition, it is necessary to eliminate the gate current, and then reduce the current flowing through the anode and cathode terminals until the current level drops lower than the SCR's holding current, and so based on this, it's necessary to have either an extra circuit or a method capable of reducing the main current flowing through the main terminals of the SCR until it is turned off.

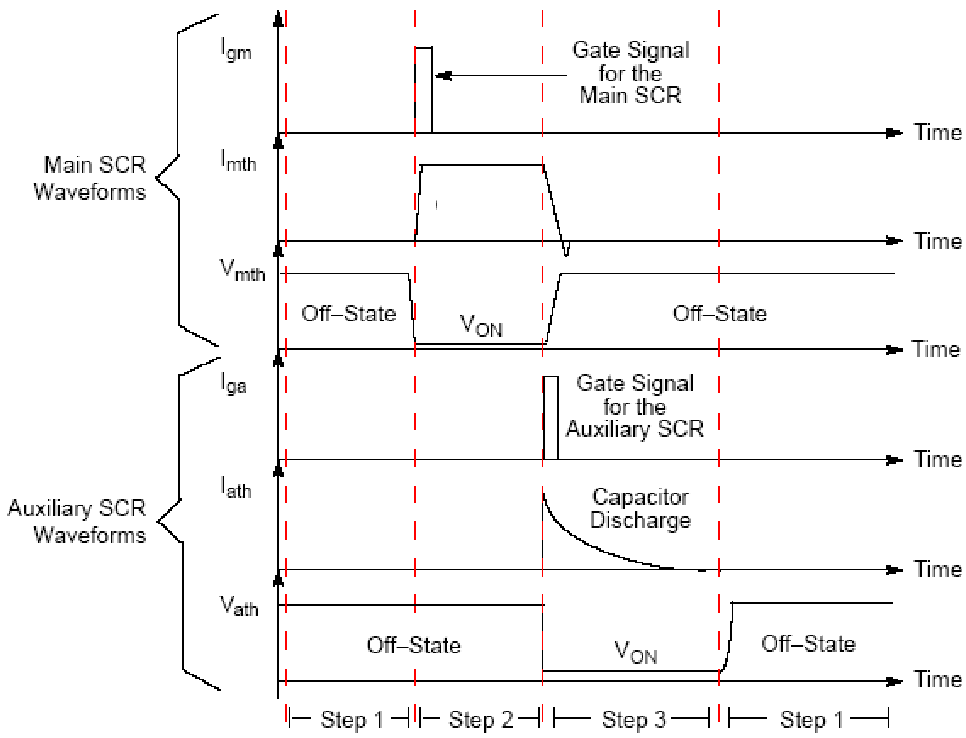
Forced Commutation Method Type E or Complementary Commutation
The figure below shows the circuit diagram for this method and its corresponding operating sequence:



The steps of the operating sequence are as follows:
Step 1. At T=0, the capacitor C is not charged and no trigger signal is being applied to the gate terminals of either SCR; therefore, there is no current flow in the circuit.

Step 2. As soon as a current pulse is applied to the gate terminal (I_{gm}) of the Main SCR, it will be triggered allowing current flow through the load, and at the same time, the capacitor will start to be charged through the Auxiliary Resistance, and once it has reached its maximum charge voltage level ($\tau = R_{aux}$), it will act as an open element, while the Main SCR will remain in

Operating Sequence Diagram



its on–state even if the current signal has been removed from its gate terminal.
Step 3. Now, when a current pulse is applied to the gate terminal (I_{ga}) of the Auxiliary SCR, it will be triggered causing the discharge of the capacitor through it (I_{ath}). Once the capacitor has been fully discharged, it will act as a short circuit and will start to be charged through the Load Resistance but now in inverse polarity through the Aux SCR. This action will cause the elimination of the current flow through the Main SCR, which will be turned off. The Auxiliary SCR will be turned off as soon as the current level of the capacitor's pulse discharge has dropped below its holding current (I_H), since the Auxiliary Resistance will not allow enough current flow through the Aux SCR to keep it in the on–state. After the Main SCR has been turned off, it could be activated again by supplying another current pulse to its gate terminal and can be deactivated in the same way as previously explained. It is important to mention that there are some points that must be taken into consideration in order to ensure the proper operation of this commutation method. These points are described below:

a. The source voltage must be less than the V_{DRM} and V_{RRM} of the Main and Auxiliary SCRs.

- V_{DRM} is the Repetitive Peak Off-State Maximum Voltage
- V_{RRM} is the Repetitive Peak Reverse Maximum Voltage

b. The operating condition for the commutation is:

- R_{aux} is the auxiliary resistance (Ohms)
- C is the capacitance to be used (Farads)
- T_q is the turn–off time of the main and auxiliary SCRs

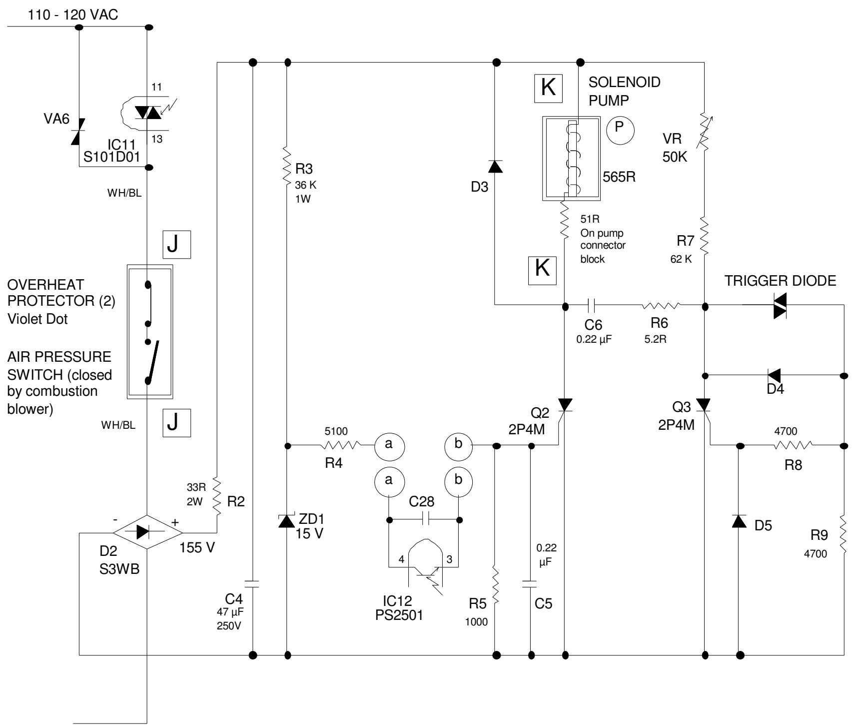
Monitor 441 Taisan Solenoid Pump Circuit
IC11 is switched on by the Microcomputer IC1 and supplies 120VAC to the diode bridge D2 through the two Klixon overheat protection switches on the front of the heat shield and the air pressure switch after it is actuated by the combustion blower. This AC voltage is full-wave rectified by D2 to 155 VDC and smoothed by R2 and C4 to about 166 VDC. The electromagnetic coil of the solenoid pump P is connected in series to a first thyristor (SCR) Q2 . A fixed resistor R7 and a variable resistor VR are connected in series to a second thyristor Q3, and all are connected in parallel to the series circuit of the above-mentioned electromagnetic pump coil P and first thyristor Q2.

Voltage divider ZD1 and R3 supply 15 VDC to the varistor gate circuit for Q2. When the firing pulse generated by the Microcomputer IC1 through photocoupler IC12 has been applied, a gate current pulse is supplied through voltage divider R4 and R5, Q2 is turned on, and current flows through the electromagnetic coil P. Upon the conduction of Q2, the charge of the comutation capacitor C6 is started through VR, R7 and R6, and when such charge has reached a predetermined value, the trigger diode TD is turned on. By this time the gate pulse on Q2 has turned off, and with the turn-on of TD, Q3 is turned on and the charge in capacitor C6 is discharged through Q3 so that Q2 is turned off. This process continues until the Microcomputer IC1 shuts it off.

The circuitry associated with Q3 is consequently intended to determine the current flow time of Q2, and the current flow time from the conduction to turn-off of Q2 may be suitably set by adjusting the required time of the capacitor C6 by means of the variable resistor VR.

Changing the charging time of C6 by adjusting VR causes the change in conduction time of the extinction thyristor Q3, and therefore the change in turn-off time of Q2. As a result, the duration time for pulse current flowing through the electromagnetic coil is varied, and therefore the magnetic attracting force produced in the electromagnetic plunger is varied.

Solenoid fuel pump pulses at 7.36 p/s in Low mode; 9.14 p/s in Low-Med mode (measured).
Pump rate is 0.319 gal/hr in high heat mode (Monitor 441 Owners Manual) = 40.832 oz/hr = 0.6805 oz/min = 20.12577 ml/min.



110 - 120 VAC
VA6
11
13
IC11
S101D01
WH/BL
J
OVERHEAT
PROTECTOR (2)
Violet Dot
AIR PRESSURE
SWITCH (closed
by combustion
blower)
WH/BL
J
33R
2W
R2
-
+
D2
S3WB
155 V
C4
47 µF
250V
R3
36 K
1W
5100
R4
a
a
b
b
ZD1
15 V
C28
4
3
IC12
PS2501
R5
1000
0.22
µF
C5
D3
K
SOLENOID
PUMP
P
565R
51R
On pump
connector
block
K
C6
0.22 µF
R6
5.2R
Q2
2P4M
VR
50K
R7
62 K
TRIGGER DIODE
D4
Q3
2P4M
4700
R8
D5
R9
4700