Silicon Controlled Rectifier (SCR)

Lecture – 19

TDC PART – I
Paper - II (Group - B)
Chapter - 5

by:

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- **SCR Turning-OFF Methods (PART – 7)**
- **Lecture Content :-**
  - **(2) Forced Commutation**
  - **(IV) Class-D Commutation - (Impulse Commutation)**

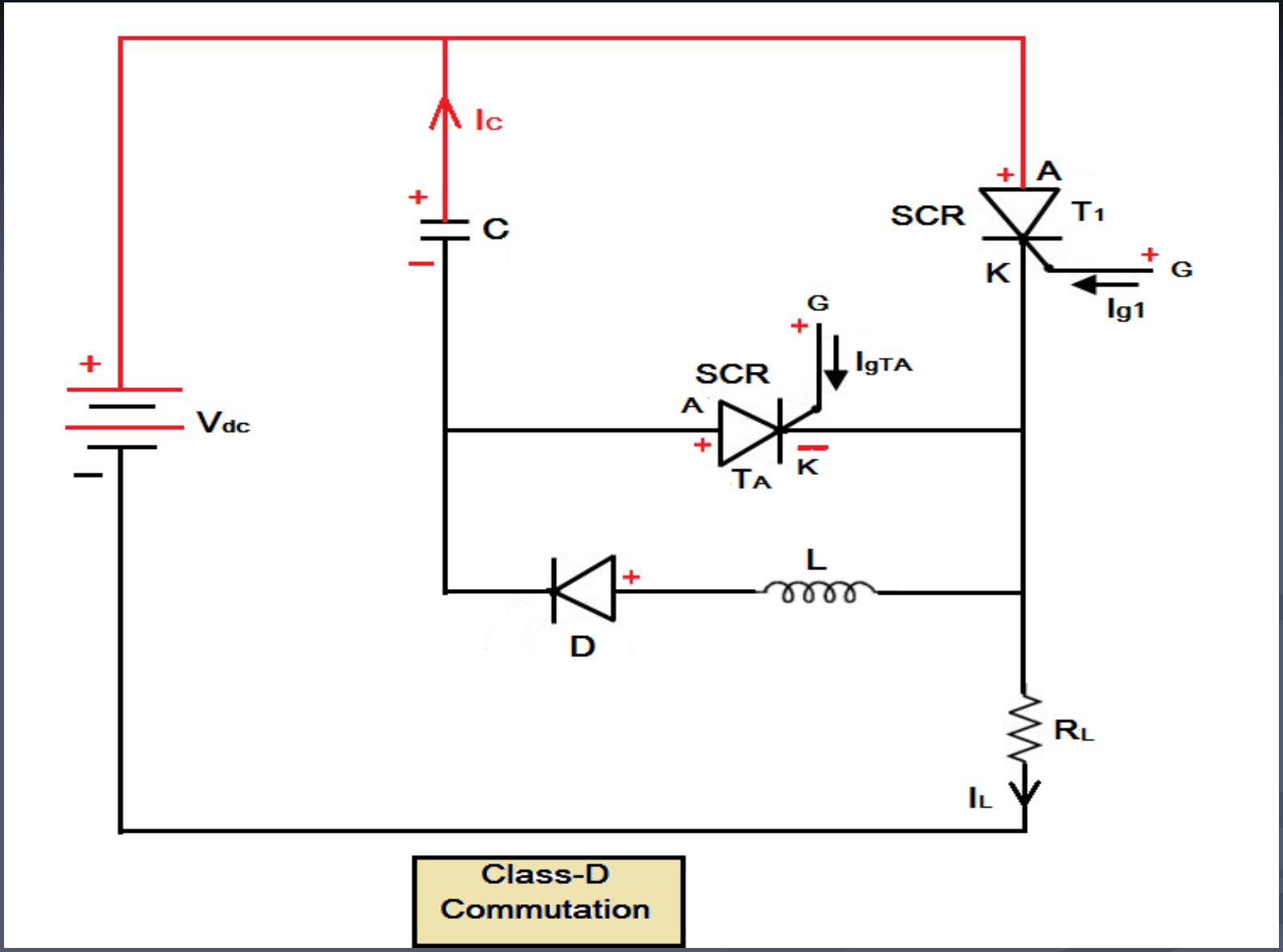
(IV) Class-D Commutation - (also Known as Impulse Commutation or Auxiliary Commutation

- Class-D Commutation is a Commutation method used to **Turn OFF SCR (thyristor) in a DC circuit** by the application of a **sudden Reverse Voltage across the terminals of SCR.** This is the reason, it is also **called Impulse Commutation.**

- A **Class-D Commutation** circuit consists of **Main SCR (thyristor) T_1, Auxiliary Thyristor T_A, Capacitor C, Diode D and Inductor L. Load Current I_L** is assumed to be constant throughout the discussion. Let us consider the commutation circuit shown in **Figure (94)** below for better understanding. Reference direction of capacitor current and capacitor voltage is shown in **Figure (94).**

- **Figure (94)** shows the **Class-D Commutation** circuit diagram which consists of two SCR (thyristor) such as main **SCR (thyristor) T_1** and **Auxiliary SCR (thyristor) T_A, Inductor L, Diode D** and a **Commutation Capacitor C.** The **Main SCR (thyristor) T_1** and **Load Resistor R_L** act as a **Power Circuit** but **Inductor L, Diode D** and **Auxiliary SCR (thyristor) T_A** are used to form the **Commutation Circuit.**

- **Figure (94)** shows the typical **Class-D Commutation Circuit.** In this commutation method, an **Auxiliary SCR (thyristor) T_A** is required to commutate the **Main SCR (thyristor) T1,** Assuming ideal **SCRs (thyristors)** and the lossless components, then the **waveforms** are as shown in **Figure (98).** Here, **Inductor L** is necessary to ensure the correct polarity on **Capacitor C. Main SCR (thyristor) T1** and **Load Resistance R_L** form the power circuit, whereas **Inductor L, Diode D and Auxiliary SCR (thyristor) T_A** form the commutation circuit.



- **Fig (94)** Shown the **Class-D Commutation** Circuit Diagram which consists of two SCRs, one Capacitor, one Inductor and one Diode .

Circuit Operations :-

- **MODE - 0 [Initial Operation] :-**
- Initially when the **Battery V_{dc}** is connected, the **DC Voltage V_{dc}** is applied to circuit, the **SCRs (thyrisors) T1 and T_A** are in **OFF-State.** There is no current Flow through DC supply and commutation circuit as both **SCRs (thyristors) T1 and T_A** are **OFF.** Hence, initially, the state / conditions of the circuit components **T1 and T_A** and **Capacitor C** may be represented by,

- **T1 is in OFF State,**
- **T_A is OFF State and**
- **$V_c = 0$**

MODE - 1 :-

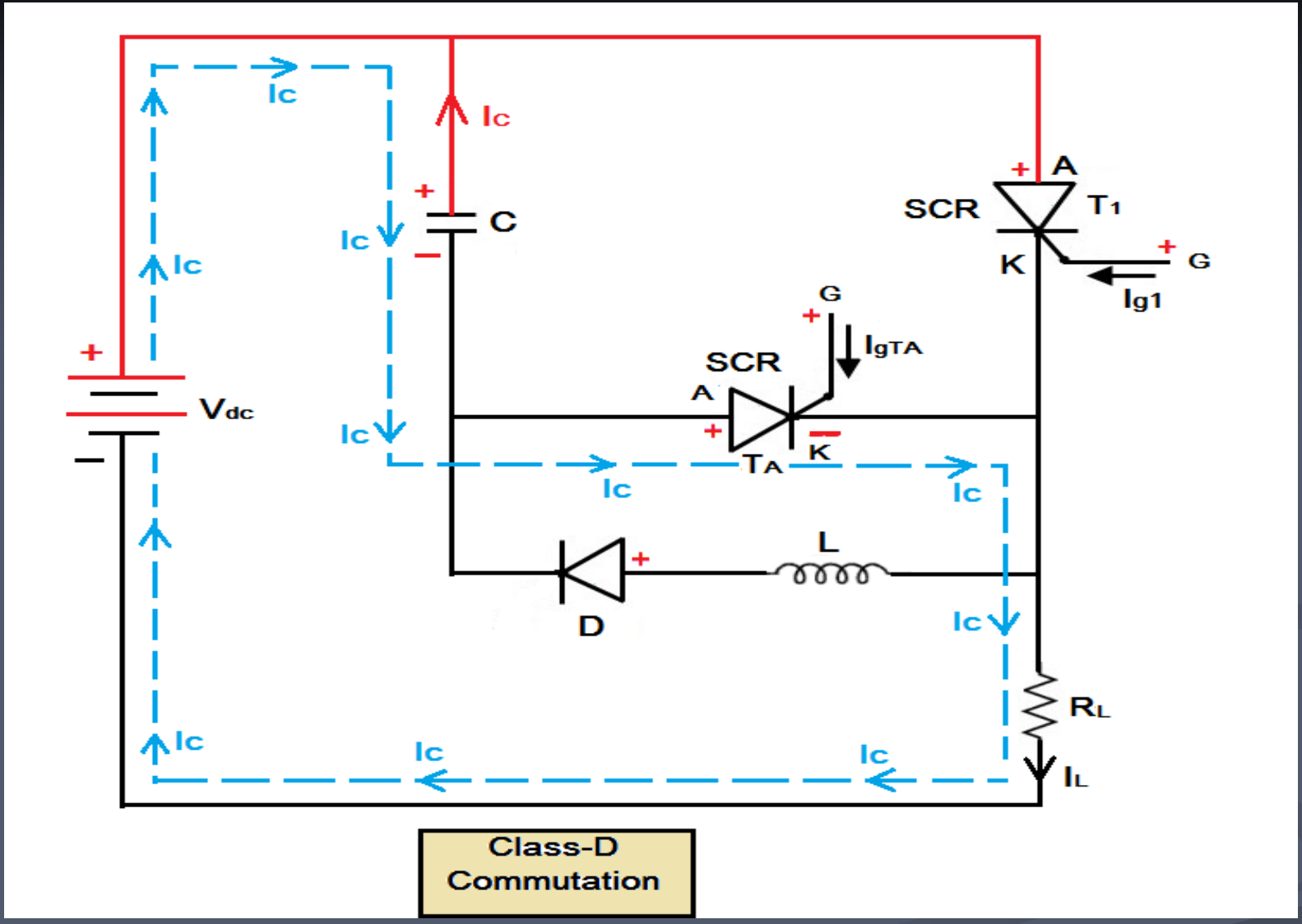
- Initially, the triggering pulse is applied to **Auxiliary SCR (thyristor) T_A, SCR (thyristor) T_A** will be **Turned ON and Capacitor C gets charged** with the polarity shown in **Figure (95) below.** . The Capacitor **Charging Current (Ic)** flows through the path,

- **$V_{dc}+ - C+ - C- - T_A - R_L - V_{dc}-$**

- As soon as **Capacitor C** is fully charged to **V_{dc}, the Auxiliary SCR (thyristor) T_A Turns OFF.** This is due to the fact that, as the **voltage across the Capacitor C increases gradually,** the **current flow through the Auxiliary SCR (thyristor) T_A decreases slowly** since **Capacitor C and Auxiliary SCR (thyristor) T_A** form the series circuit.

- Hence in this **MODE – 1 Operation,** as shown in **Figure (95)** below, the **State / Conditions** of circuit components **T_1 and T_A** and **Capacitor C** may be represented by,

- **T_1 is in OFF State,**
- **T_A is OFF State and**
- **$V_c = V_{dc}$**



- **Fig (95)** Shown the **Class-D Commutation** Simplified Circuit Diagram which consists of two SCRs and one Capacitor C with SCR T1 is in OFF State and SCR TA is OFF State.

MODE - 2 :-

- When the triggering pulse is applied to **Main SCR (thyristor) T_1**, the current flows in two different paths,

- **(a)** The **Load Current I_L** follows through the following path,

- **$V_{dc}+ - T_1 - R_L - V_{dc}-$**

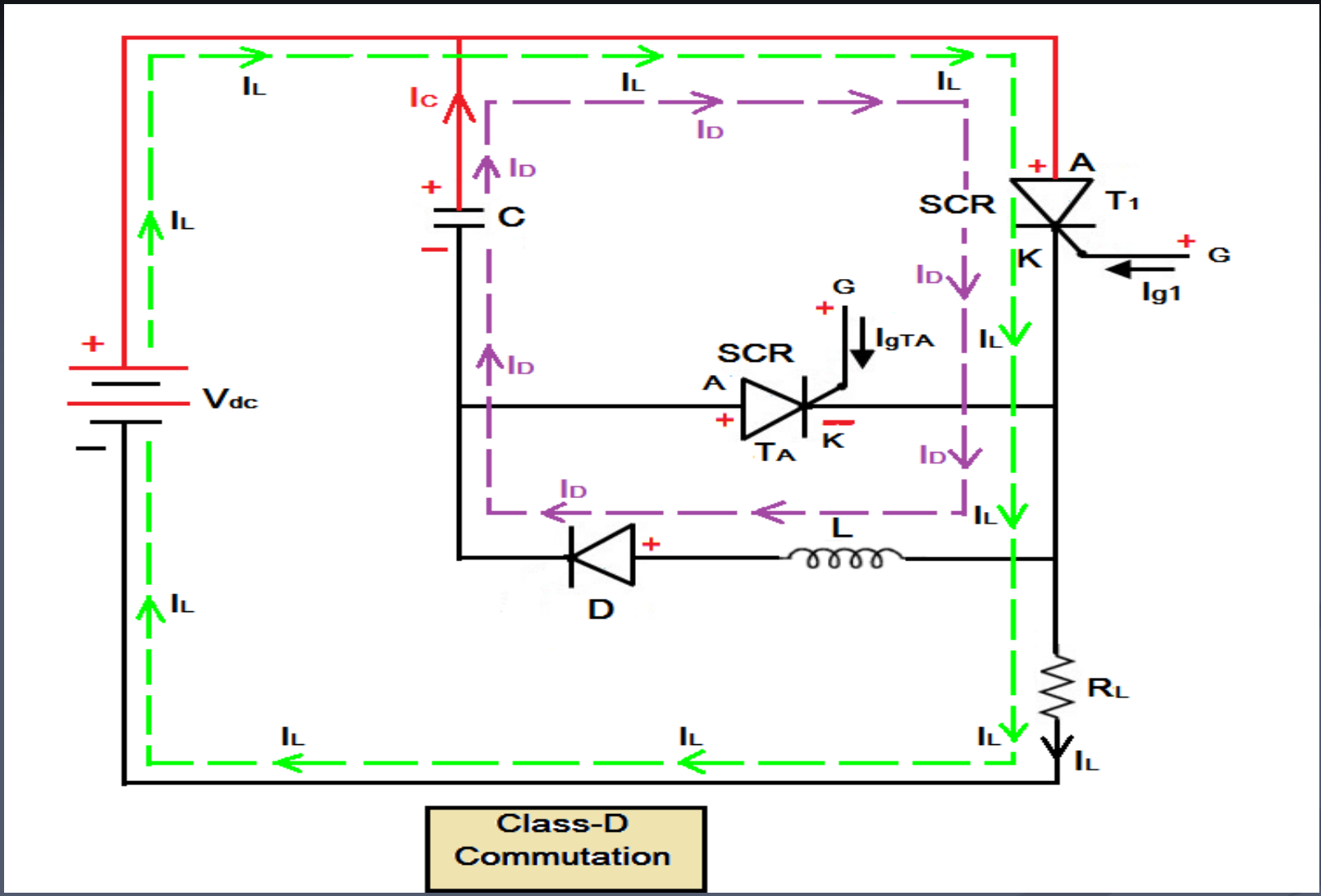
- **(b)** and **Commutation Current (Capacitor-Discharges Current) (I_D)** flows through the following path,

- **C+ – T_1 – L – D – C–**

- After the **Capacitor C** has **completely discharged,** its **polarity** will be **reversed,** i.e., its **Upper Plate will acquire Negative Charge** and the **Lower Plate will acquire, Positive Charge.** Reverse discharge of **Capacitor C** will not be possible due to presence of blocking **Diode D.**

- Therefore, at the end of **Mode – 2 Operation,** as shown in **Figure (96)** below, the **State / Condition** of the circuit components **T_1 and T_A** and **Capacitor C** may be represented by,

- **T_1 is in ON State,**
- **T_A is in OFF State and**
- **$V_c = -V_{dc}$**



- **Fig (96)** Shown the **Class-D Commutation** Simplified Circuit Diagram which consists of two SCRs, one Capacitor, Inductor, and a Diode with SCR T1 is in ON State and SCR TA is in OFF State.

MODE - 3 :-

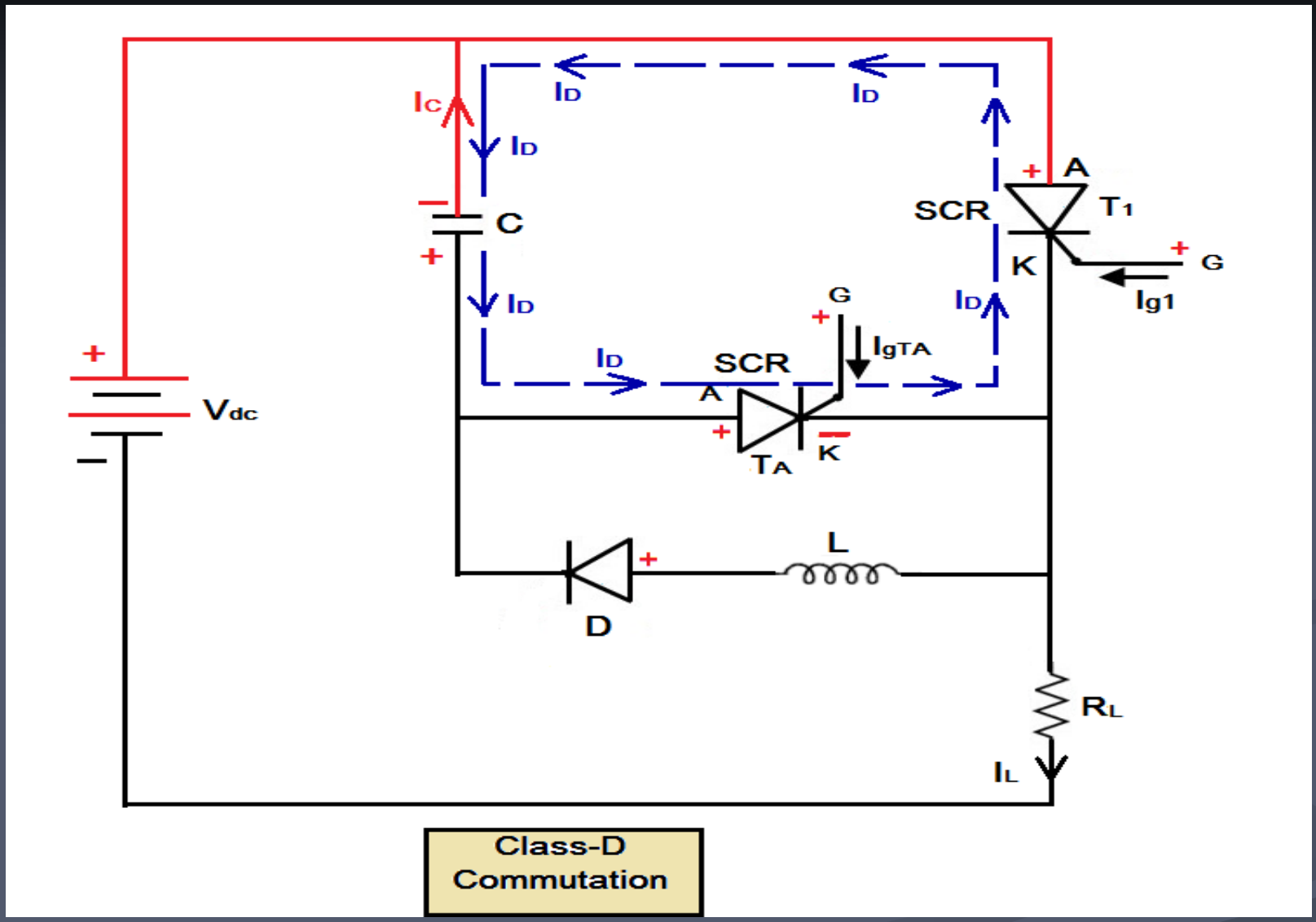
- In this mode, whenever the **Auxiliary SCR (thyristor) T_A** is triggered and **Turned ON, Capacitor C** starts to **discharge** through the following path,

- **$C+ - T_{A(A-K)} - T_{1(k-A)} - C-$**

- When this **Commutation Current (Discharging Current of Capacitor C) (I_D)** becomes more than the **Load Current I_L, SCR (thyristor) T_1 gets Turned OFF.**

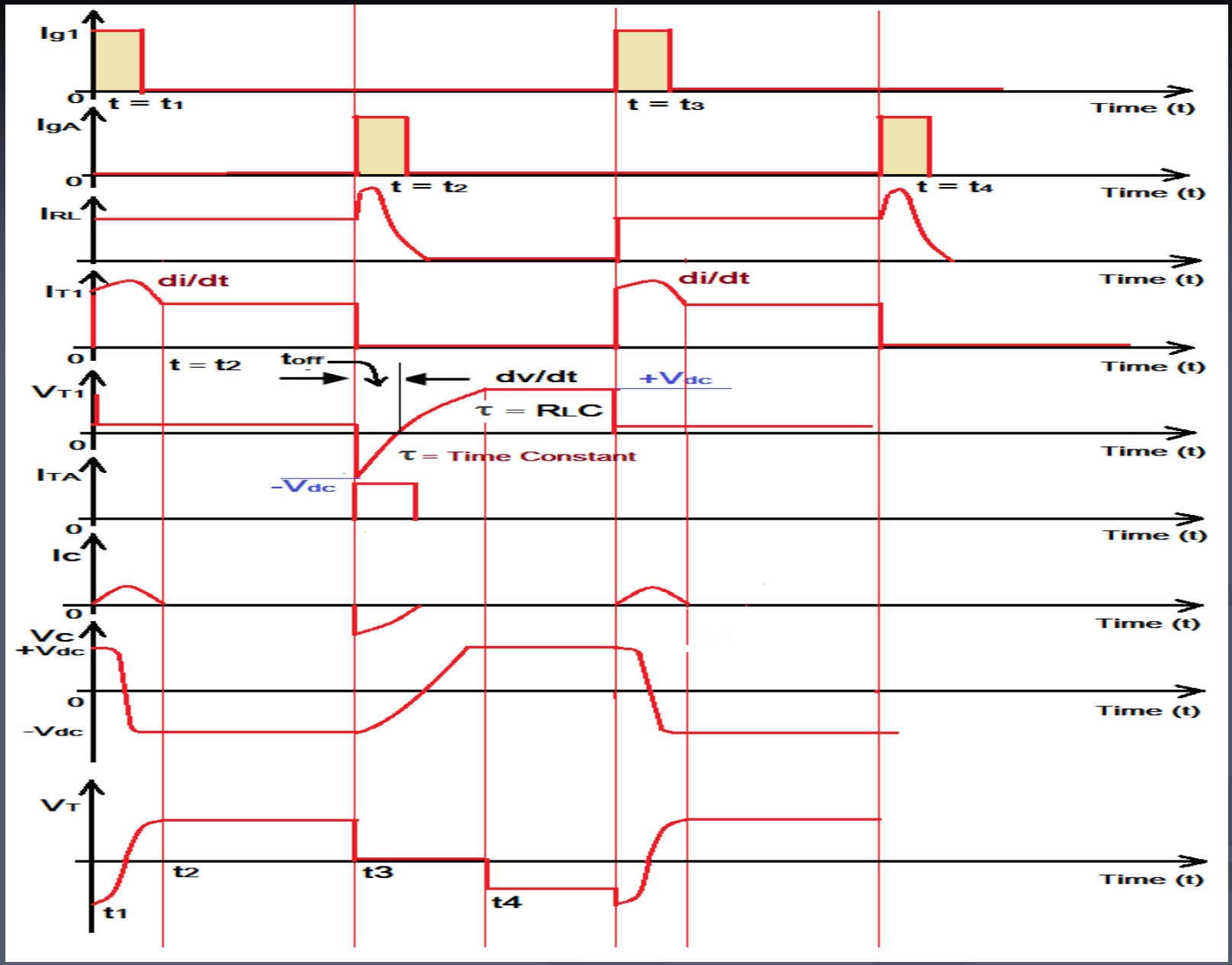
- Therefore, at the end of **Mode – 3 Operation,** as shown in **Figure (97)** below, the **State / Condition** of circuit component **T_1 and T_A** becomes,

- **T_1 is in OFF State and**
- **T_A is OFF State**



- **Fig (97)** Shown the **Class-D Commutation** Simplified Circuit Diagram which consists of two SCRs, one Capacitor, Inductor, and a Diode with SCR T1 is in OFF State and SCR TA is in OFF State.

- Again, **Capacitor C** will charge to the **Supply Voltage V_{dc}** with the polarity as shown in **Figure (95)** and hence **Auxiliary SCR (thyristor) T_A gets Turned OFF**. Therefore, **SCRs (thyristors) T_1 and T_A both get Turned OFF,** which is equivalent to **Mode - 0** operation. Since the **Commutation Energy** rapidly transfers to the load, high efficiency is possible in **Class-D Commutation**. This Commutation is most commonly used in **Jones Chopper Circuit.**



- **Fig (98)** Shown Voltage and Current Waveforms of Class-D Commutation.

- **Class-D Commutation** is also **known as Auxiliary Commutation** due to the fact that **Auxiliary SCR (thyristor) T_A** is used for the **commutation of Main SCR (thyristor) T_1.** When **Auxiliary SCR (thyristor) T_A is ON, Capacitor C** gets connected across the terminals of **Main SCR (thyristor) T_1,** therefore this method of commutation is also called **Parallel Capacitor Commutation.**

to be continued .....