1. Dual converters provide four quadrant operation

   Dual converters provide four quadrent operation, which means voltage can be positive or negative and so can be the current. Hence, AC-DC, DC-AC any converter configuration can be used.

2. A dual converters has two full converters in anti-parallel

   Dual converters have two full converters connected in anti-parallel which provides a four quadrant operation.

3. The major advantage of using dual converters is that no mechanical switch is required to change the mode of operation

   No mechanical arrangement is required to change from inverter to converter and converter to inverter, which was required in earlier methods.

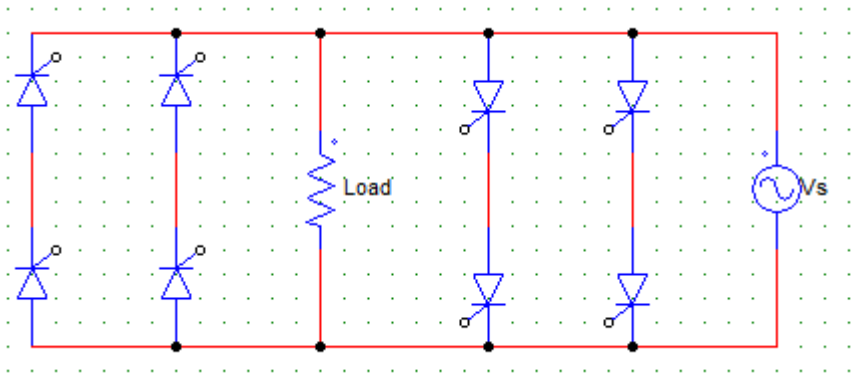
4. The four quadrant operation of dual converters can be obtained by changing the firing angle value

   The four quadrant operation can be obtained simply by adjusting appropriate values of firing angles for both the connected converters.

5. A single full converter alone can given a two quadrant operation

   A single full converter alone gives two quadrent operation, hence for all four quadrant operation two full converter circuits are connected in anti-parallel.

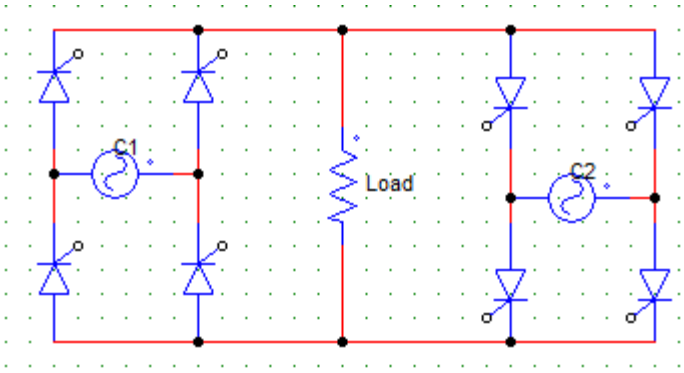
6. Find the error in the below given dual converter circuit.



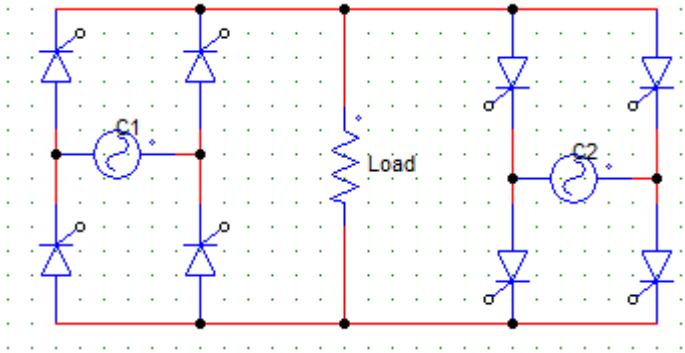
   Voltage source is not connected for one of the converter circuit

   Voltage source is not connected in the proper place

   Explanation: The right connection for single-phase dual converter is shown below.

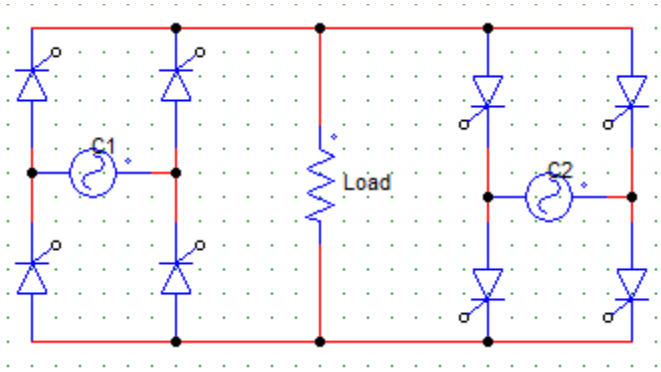


7. In the below given circuit, the right side converter C2 operates in the second and third quadrant.



The C2 converter will supply the load current in direction opposite to that supplied by the converter C1. For converter C2, when α> 90 it operates in 2nd quadrant and if α<90 both current and voltage are negative, C2 is in inverter mode and operates in 3rd quadrant.

8. Name the below given circuit. Single-phase dual converter non-circulating current type



The circuit is a single phase dual converter circuit. As the there is no reactor (inductor) in series, it is a non-circulating type.

9. For a single-phase dual converter, with converters C1 and C2 connected in anti-parallel, which relation among the following is true to keep the average voltages from C1 and C2 equal? C1 and C2 have firing angles α1 and α2 respectively.

$\alpha 1 + \alpha 2 = 180°$

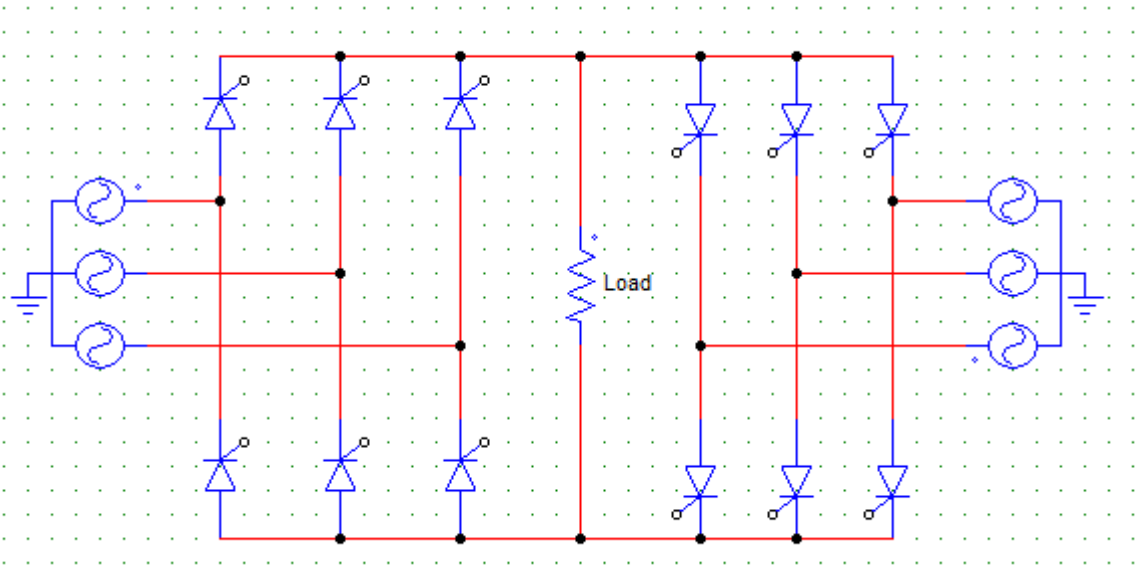
10. In non-circulating current mode dual converters, the circulating current is avoided by operating only one converter
    Reactor is added in circulating current mode not in non-circulating mode. The circulating current is avoided by using only one of the converters.

1. In circulating current mode dual converters, the circulating current is avoided by connecting a series reactor

Reactor is added in circulating current mode not in non-circulating mode. The reactor limits the current to a reasonable value.

2. Choose the correct statement
c) Circulating current exists in both the circulating and non-circulating current mode
The circulating current does exist in both the converter circuits, but it is avoided by using a reactor in non-circulating type and by operating only one circuit in case of circulating type.
3. What causes circulating current in dual converters?
c) Out of phase voltages from both the converters
In case of practical dual converters, the voltages from both the converter circuits though equal in magnitude is out of phase. This indifference in voltages causes circulating currents to flow.

4. Name the below given circuit.



Three-phase dual converter with non-circulating current type

The circuit is a three phase dual converter circuit. As the there is no reactor (inductor) in series, it is a non-circulating type.

5. In case of three-phase dual converter, one of the converter circuits is fired at an angle of 60°. For both the converter circuits to have equal average output voltage, what is the value of the firing angle for the other converter circuit?
120°

For equal average output voltage, α1 + α2 = 180°.

6. In case of circulating current type dual converters, the reactor is inserted between between the converters

Reactor (inductance) is added in circulating current mode between both the converters. The reactor limits the current to a reasonable value.

7. Choose the correct statement.
Circulating current type is faster in operation

In case of non-circulating type, to shift the operation from one mode to another mode a delay of 10 to 20msec is required to let the current decay to zero value and let the outgoing SCRs safely turn off. This delay is not required in case of circulating current mode.

8. Circulating current flows from one converter to another converter

The circulating current flows only between the converters and not to through the load.

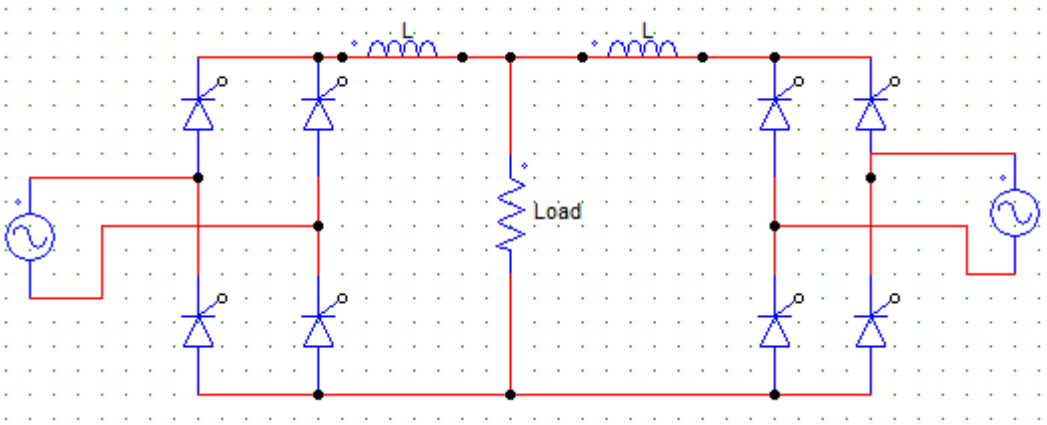
9. The reactor in circulating current type dual converters
increases losses,
reduces power factor
increase the weight of the circuit

All of the above mentioned are the major drawbacks of using reactors to reduce circulation current.

10. If V1 and V2 are the instantaneous voltages of the two converter circuits in the dual convert, then the output voltage is
b) (V1 + V2)/2

The load voltage is the average value of the instantaneous converter outputs.

Name the circuit shown in the figure below.

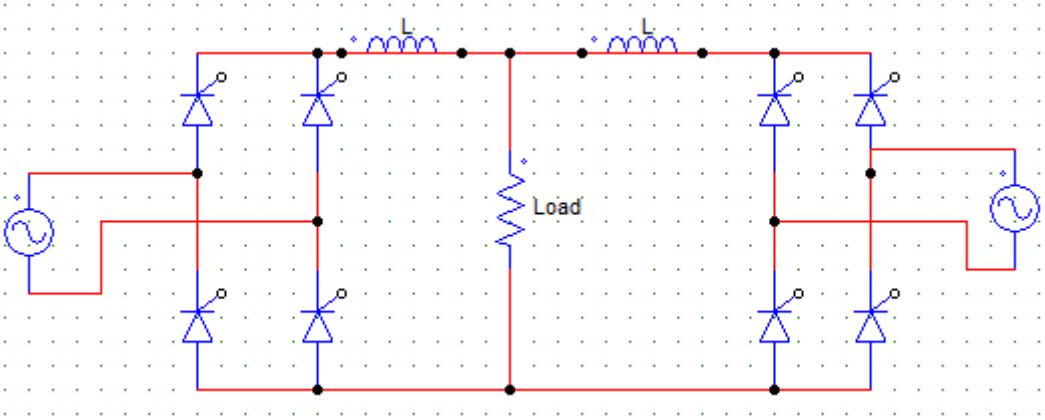


The converters are connected in parallel not in anti-parallel.

2. Dual converters handle only circulating current during no load.
a) very high temperature

During no load period, both the converters handle only the circulating current as the load current is zero.

3. In a three phase dual converter, converter 1 is operating with α = 95° and converter 2 is operating with α2 = 85°. Choose the correct statement.
c) Converter 1 is operating as a inverter and converter 2 as an rectifier
As α1 > 90, converter 1 is operating as a inverter and with α2<90, converter 2 is working as an inverter.
4. The circuit shown below is that of a



c) three-phase circulating current type dual converter

It is a 3-phase as it uses 6 SCRs on either sides, it is circulating current type as there is a reactor (L) placed on either sides of the load to compensate for the circulating current.

5. In circulating current type of dual converters, the nature of voltage across the reactor is alternating

The current is alternating in nature.

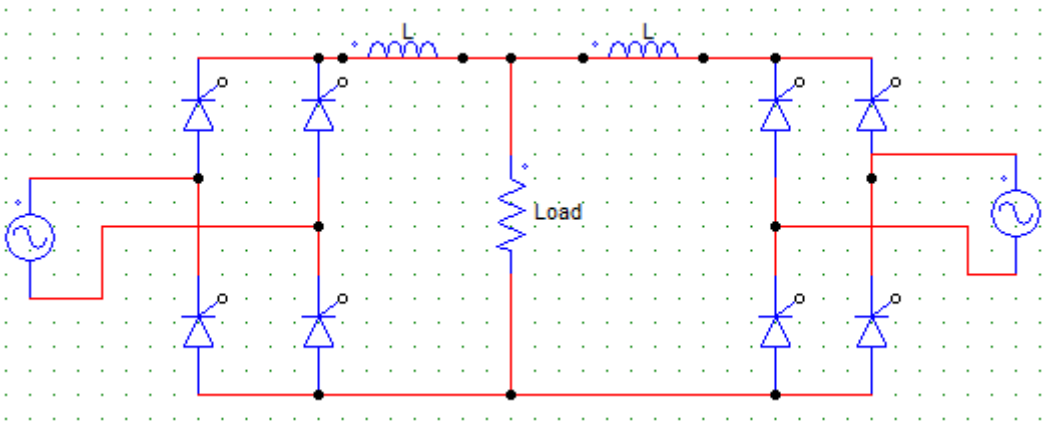
6. When a line commutated converter operates in the inverter mode then it delivers real power to the supply

A converter is given an AC supply, when it is in the inverter mode, it is sending power (only real power) to the AC supply and absorbing power (only reactive) power from the supply.

7. The reactor is required in a circulating current type dual converter to
limit the circulating current

Reactor (inductance) is introduced in the circulating current mode between both the converters. The reactor limits the current to a reasonable value.

8. In the below given figure the converter 1 (to the right side) has firing angle = α1, converter 2 has firing angle = α2. For the dual converter to operate in the second quadrant.



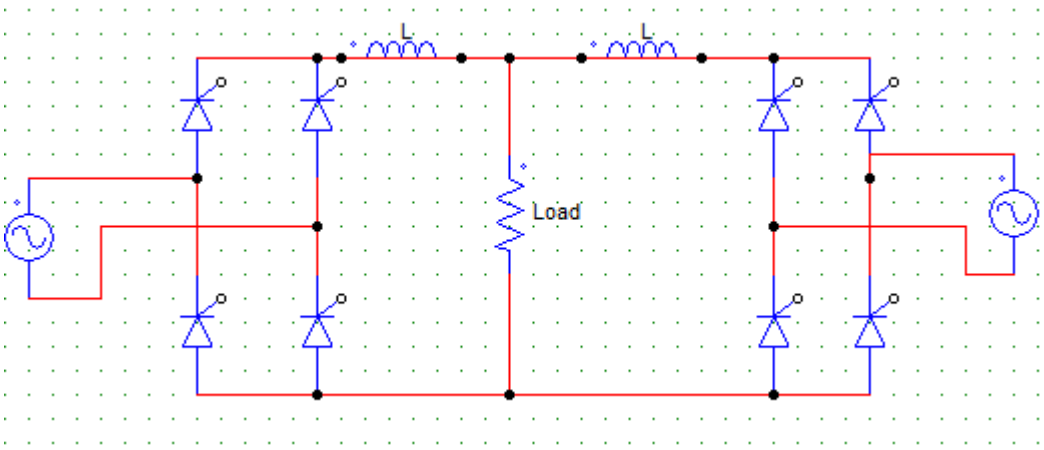
α2 > 90°

Converter 1 would control the first and the fourth quadrant and converter 2 would operate in the second and the third quadrant. In the second quadrant, voltage should be positive and current should be negative, hence inverter operation hence α2 > 90°.

9. If V1 and V2 are the converter output voltages then the reactor voltage is V1 – V2

The reactor voltage Vr is the difference of the converter output voltages.

10. In the below given figure, the converter 1 (to the right side) has firing angle = α1, converter 2 has firing angle = α2. For the dual converter to operate in the fourth quadrant.



α1 > 90°

Converter 1 would control the first and the forth quadrant and converter 2 would operate in the second and the third quadrant. In the fourth quadrant, voltage should be negative and current should be positive, hence C1 as an inverter is operated with α1 > 90°.

Question

A single-phase dual converter is fed from 230 V, 50 Hz source. The load is R= 30 Ω and current limiting reactor has L = 0.05 H. For $\alpha_1 = 30°$, calculate the peak value of circulating current.

Solution

$$i_{cp}=2V_m\omega L[1-\cos\alpha_1]$$

$$=2\sqrt{2}\times 230\sqrt{2}\pi\times 50\times 0.05[1-\cos 30_o]=5.548\text{Amp}$$

A three phase dual converter, operating in the circulating current mode, has the following data:

Per phase supply voltage =230V
Supply frequency , f=50Hz
Firing angle $\alpha_1=60^o$
Current limiting reactor, L=15mH
The peak value of circulating current is _____ A.

Solution

The peak value of circulating current

$i_{cp}=\sqrt{3}V_{mL}\omega L[1-\sin\alpha_1]$

$=\sqrt{3}.\sqrt{6}.2302\pi\times50\times15\times10^{-3}[1-\sin 60^o]$

$=27.74A$

Two 3-ϕ full converters are connected in antiparallel to form a 3-ϕ dual converter of the circulating current type. The input to the dual converter is 3-ϕ, 400 V, 50 Hz. Peak value of the circulating current is to be limited to 15 A. If the firing angle $\alpha_1=30^o$**, value of inductance needed is**

Solution

Peak circulating current,

$i_{CP}=\sqrt{3}V_{m1}\omega L(1-\sin\alpha_1)$

$15=\sqrt{3}\times400\sqrt{2}100\pi L(1-\sin30^o)$

L = 104.0 mH

Question

A $3-\phi$ 3 pulse converter, fed from $3-\phi$, 400 V, 50 Hz supply, has a load $R=2\Omega$, E = 200 V and large inductance so that load current is constant at 20 A. If source has an inductance of 2 mH, then the value of overlap angle for inverter operation is

$V_0=-E_0+I_0R$

$3V_{ml}2\pi\cos\alpha-3\omega L_s2\pi I_0=-E_0+I_0R$

$270.094\cos\alpha=-154$

$\alpha=\cos^{-1}(-154270.094)$

$\alpha=124.76^\circ$

For a $3-\phi$ converter,

$I_0=V_{mL}2\omega L_s[\cos\alpha-\cos(\alpha+\mu)]$

$20=\sqrt{2}\times4002\times2\pi\times50\times2\times10^{-3}[-0.5701-\cos(\alpha+\mu)]$

$=450.1581(-0.5701-\cos(\alpha+\mu))$

$\cos(\alpha+\mu)=-0.6145$

$\mu=127.91^\circ-124.76^\circ$

$\mu=3.15^\circ$

Question

A single phase full converter is supplied from $230V,50Hz$ source. The load consists of $R=10\Omega$ and a large inductance so as to render the load current constant. For a firing angle of 30_o, the average and rms values of thyristor currents respectively are

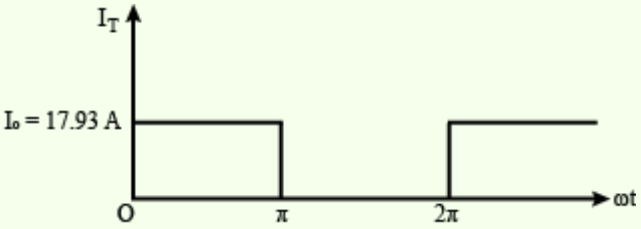
Solution

Average output voltage of single phase full converter is

$V_0=2V_m\pi\cos\alpha$

$V_0=2\sqrt{2}\times230\pi\cos30_o=179.33V$

$I_0=V_0R=179.3310=17.93A$



The average value of thyristor current,

$I_{T,avg}=17.93\times\pi2\pi=8.96A$

The rms value of thyristor current,

$I_{T,rms}=17.93\times\sqrt{\pi2\pi}=12.67A$