2016/2017
CECE455

Sheet_Inverter

"Control Method of 1-ϕ H-Bridge"

Selected Topics in Electrical Energy systems

[1] The output voltage of single-phase H-bridge Inverter is controlled by single-pulse Modulation per each half cycle of the output voltage. Calculate: The rms values of fundamental, 5Th, 7Th harmonic component of the output voltage for pulse-width = 90°. ALso Calculate the THD for the output voltage.

[Answer: $V_{1rms} = 63.66\% V_{dc}$, $V_{5rms} = -12.73\% V_{dc}$, $V_{5rms} = -9.09\% V_{dc}$
$THD_v = 48.3\%$]

[2] The output voltage of a single-phase full-bridge inverter is controlled by pulse-width modulation with one pulse per half-cycle. Determine the required pulse width so that the fundamental rms component of the output voltage is 70% of dc input voltage.

[Answer : $\delta = 102.07°$]

[3] The output voltage of single-phase full-bridge inverter is controlled by single-pulse modulation. If the load is purely resistive and the pulse-width = 90°.

Calculate : (i) rms output voltage.
(ii) fundamental rms component of output voltage.
(iii) Total harmonic distortion for output voltage and current.

[Answer : (i) $70.7\% V_{dc}$ (ii) $V_{1rms} = 63.66 V_{dc}$
(iii) For Resistive Load : $THD_v = THD_i = 48.3\%$.]

[4] Design a single-phase Full-bridge Inverter used with RL Load of $R = 10\Omega$, $L = 25mH$. The fundamental Component of output Current has an amplitude of 9.27A, but with a ToTaL harmonic distortion of Less Than 10%. Adjustable dc Source is available. output Frequency is 60 HZ.

[Answer: • 1-ϕ H-bridge with single-pulse modulation.
• $V_{dc} = 116\,V$
• $\delta = 120°$ (i.e: Instant of Switching For T_1 Corresponds To $\alpha = 30°$)]
• $THD_i = 6.6\%$]

[5] The output Value of The fundamental Component of The output Voltage in 1-phase bridge inverter must be $0.45\,V_{dc}$ where V_{dc} is The Source Voltage. Calculate pulse-width required and ToTaL harmonic distortion of output Voltage:
(i) output Voltage is Controlled by 1-Pulse Modulation is employed.
(ii) output Voltage is Controlled by Multi-Pulse Modulation is employed in which There are Ten pulses per each half Cycle of The output Voltage.

[Answer: (i) $\delta = 60°$ & $THD_v = 80\%$]
(ii) $\delta = 5.73°$ & $THD_v = 75.6\%$

[6] The Single-Phase Full-bridge inverter, The dc Source is 125V, The Load is series RL Connection with $R = 10\Omega$, $L = 20mH$ and The Switching Frequency is 60 HZ.
(a) Using single-pulse modulation To determine The Value of Pulse-width and The switching angle of T_1 To produce an output Voltage of an amplitude 90V at The fundamental Frequency.
(b) Determine The ToTal harmonic distortion of output Voltage.

[Answer: (a) $\delta = 68.87°$ & $\alpha = 55.56°$
(b) $THD_v = 69\%$ & $THD_i = 2.85\%$.

7 A single-phase bridge inverter produces single-pulse per half cycle of output voltage waveform. This inverter is used to supply RL series load with $R = 10\,\Omega$ and $L = 35\,mH$. The dc input voltage is 200V and the output frequency is 60HZ.

(a) determine fundamental rms current component of output current when $\alpha = 0$.

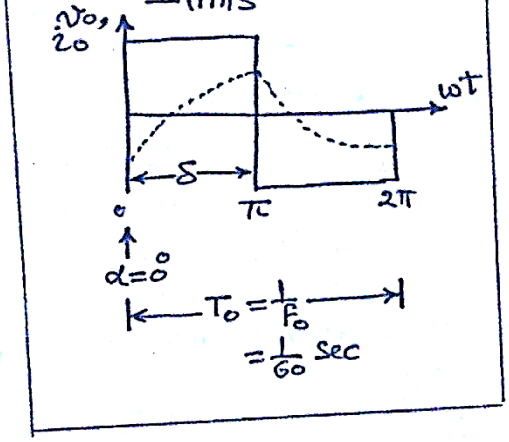
(b) if $f_o = 30\,HZ$ .... determine value of α to produce the same value of fundamental rms current in (a).

Answer:

(a) $\because \alpha = 0$

$\therefore \delta = 180°$

$I_{1rms} = 10.87A$

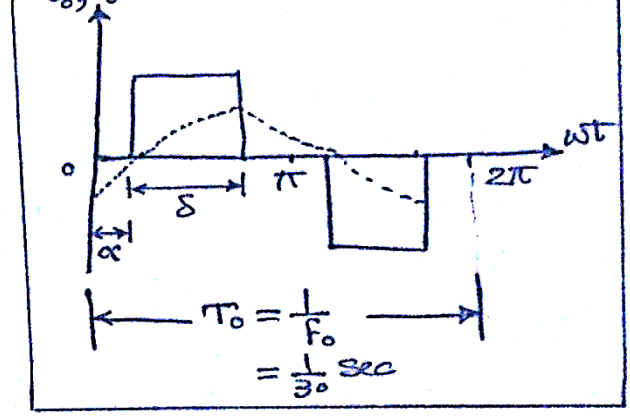


(b) $\because f_o = 30HZ$

$\because I_{1rms}(a) = I_{1rms}(b)$ (Required)

$\therefore \alpha = 43.66°$

$\therefore \delta = 92.67°$



8 Determine the value of α that will eliminate the 7^{Th} harmonic from the inverter of output voltage in problem no.

[answer: $\sin(\frac{7\delta}{2}) = 0$ → $\delta = 0$ (Refused)

→ or $\delta = 51.43° \dots\dots > \alpha = 64.29°$

→ or $\delta = 102.9° \dots\dots > \alpha = 38.57°$]

[9] Construct a Matlab/simuLink Model For problem No. (4).

[answer: single_ph_H_Bridge_SinglePulseControL.mdL]

[10] Construct a Matlab/simulink model For 1-phase Full-bridge inverter with single-pulse Modulation: $V_{dc} = 125V$, $\alpha = 30°$, $f_o = 50 HZ$, $R = 10\Omega$, $L = 20 mH$.

[answer: singlephHBridgeSinglePulse.mdL]

[11] Construct a Matlab/Simulink model For 1-phase Full-bridge inverter with Unipolar pulse width modulation: $V_{dc} = 75V$, $f_o = 50HZ = f_r$, $f_{carrier} = 500 HZ$, $M = \frac{A_r}{A_c} = 0.5$, $R = 3\Omega$, $L = 10mH$

reference ↑ (f_r)

(note: f_r : frequency of reference wave form.
f_c : frequency of carrier waveform.
A_r : Amplitude of reference waveform.
A_c : Amplitude of Carrier waveform.
M : is Modulation index)

[answer: single_phase_unipolar.mdL]

[12] Construct a Matlab/simulink model For 1-phase Full-bridge inverter with Bipolar pulse width modulation: $V_{dc} = 150 V$, $f_o = f_r = 50 HZ$, $f_c = 500 HZ$, $M = 0.5$, $R = 3\Omega$, $L = 10 mH$.

[answer: single_Pulse_bipolar.mdL]

☺ If You make a good PWM Technique with You 1-phase Full-bridge inverter, Then You will buy a filter of less price To reduce harmonics of output.

كلما استخدمت طريقة مثلى مع المحولي التشغيل كلما كان الفلتر المستخدم هو بأقل ثمن.

13 Construct a Matlab/Simulink model For 1-phase Full-bridge inverter with Bipolar PWM: $V_{dc} = 100\,V$, $m_a = 0.8$, $f_r = 60\,Hz$ $m_f = 21$ (i.e: $f_c = 21 * 60 = 1260\,Hz$). The Load has a resistance of $R = 10\,\Omega$ and Series inductance $L = 20\,mH$. Determine THD_i & THD_v.

[answer: $THD_i = 9.078\%$, $THD_v = 145.4\%$]

"You Can look at Example 8.8 , Example 8.9 in The Reference of Daniel W. Hart Page: 363 → 365 in Book Page"

"Also, You Can look at Pages: 366 → 373 in The Same Reference"

14 A Single-phase full-bridge inverter Controls The power in a resistive Load. The normal value of input dc voltage is $V_s = 220\,V$ and a uniform PWM with five pulses per half cycle is used. For The required Control, The width of each pulse is 30°. determine

(a) rms voltage of The Load.

(b) To maintain The same load power (i.e: $V_{orms(a)} = V_{orms(b)}$), if The maximum possible Pulse width is 35°, determine The minimum allowable Limit of The dc input Source.

(c) To maintain The same Load power (i.e: $V_{orms(a)} = V_{orms(c)}$), Determine The Pulse width if The dc supply is increased 10%.

[answer: (a) $V_{orms} = 200.8\,V$ (b) $V_{dc} = 203.68\,V$ (c) $\delta = 24.79°$]

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