A NEW CARRIER-BASED DISCONTINUOUS PWM MODULATION METHODOLOGY FOR FOUR-LEG VOLTAGE SOURCE INVERTERS

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ABSTRACT : A new carrier-based discontinuous pulse-width modulation (PWM) scheme anchored on a novel Space Vector modulation methodology is proposed in this paper for four-leg converters. Using a Space Vector definition that includes the zero sequence voltage component and partitioning the feasible sixteen modes into three separate sets, the expressions for the modulation signals for the discontinuous carrier based PWM scheme are set forth. Significantly, the switching devices can be clamped either to the positive or negative rail for 120 degrees under all operating conditions of unbalanced three-phase voltages; ensuring the reduction of switching losses and the effective switching frequency of the inverters. The discontinuous PWM modulation methodology proposed which is shown by experimental results to synthesis desirable balanced or unbalanced three-phase voltage sets complements and further clarifies the results of the 3-dimesional Space Vector Modulation scheme (3-D SVM) for four-leg converters reported in the literature.

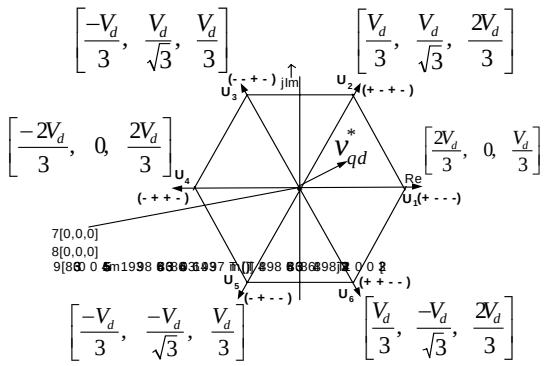
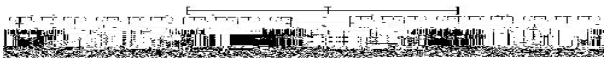
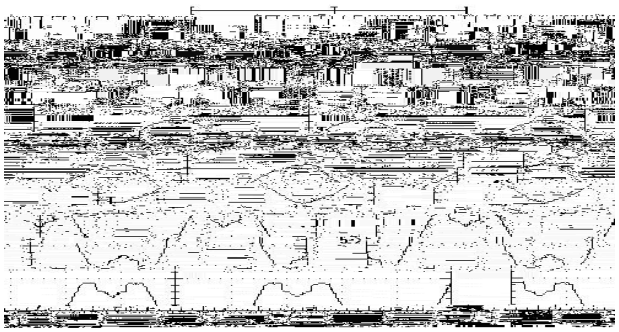

$\left[\frac{-V_d}{3}, \frac{V_d}{\sqrt{3}}, \frac{V_d}{3}\right]$
$\left[\frac{V_d}{3}, \frac{V_d}{\sqrt{3}}, \frac{2V_d}{3}\right]$
$\left[\frac{-2V_d}{3}, 0, \frac{2V_d}{3}\right]$
$\left[\frac{2V_d}{3}, 0, \frac{V_d}{3}\right]$
v^*_{qd}
Im
Re
U1(+ - - -)
U2(+ - + -)
U3(- - + -)
U4
(- + + -)
U5
(- + - -)
U6
(+ + - -)
7[0,0,0]
8[0,0,0]
$\left[\frac{-V_d}{3}, \frac{-V_d}{\sqrt{3}}, \frac{V_d}{3}\right]$
$\left[\frac{V_d}{3}, \frac{-V_d}{\sqrt{3}}, \frac{2V_d}{3}\right]$

Table III : Value of t_d for all four active switching mode combinations

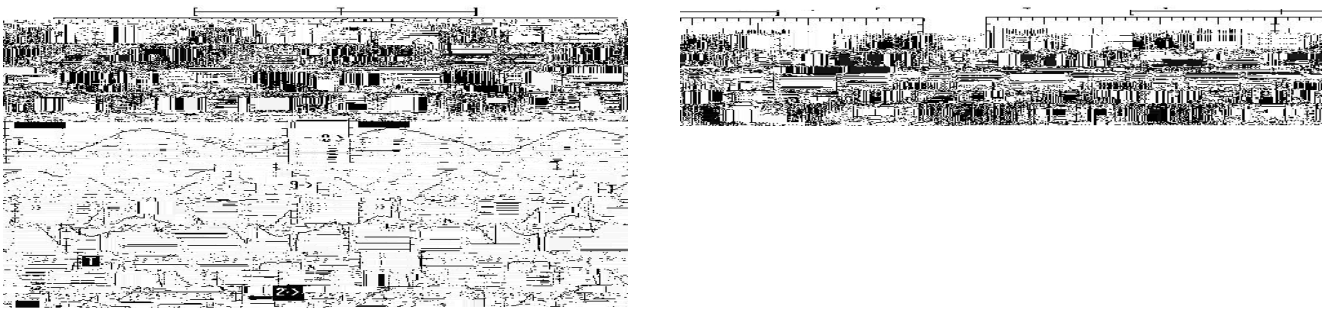
Sector	**I**	**II**	**III**	**IV**	**V**	**VI**
$t_{d(p)}$	V_{bdd}					





(a) $t_d = t_{dmax}$ (b) $t_d = t_{dmin}$

Figure 4: Experimental results : Generation of balanced three-phase voltages using discontinuous modulation scheme. V_{an} = 30 cos (377t), V_{bn} =30 cos (377t - 2π/3), V_{cn} =30 cos (377t + 2π/3) V_d = 60V. (1-2) Line voltages V_{ad}, V_{cd} , (3-4) Filtered line voltages V_{ad}, V_{cd} , (5-8) Modulating signals of the top four devices, S



(a) $t_d = t_{dmax}$ (b) $t_d = t_{dmin}$

Figure 6: Experimental results : Generation of unbalanced three-phase voltages using discontinuous modulation scheme. V_{an} = 10 cos (377t), V_{bn} =30cos (377t - 2π/3), V_{cn} = 30 cos (377t + π) V_d = 60V. (6-7) Line voltages V_{ad}, V_{cd} , (3-4) Filtered line voltages V_{ad}, V_{cd} , (1-4) Modulating signals of the top four devices, S_{ap}, S_{bp} , S_{cp}, S_{dp} , (5) t_d