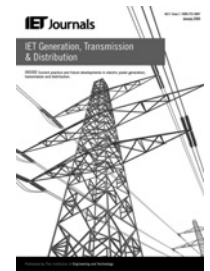


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Individual-phase decoupled P - Q control of three-phase voltage source converter

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Abstract: Individual-phase control has six control degrees of freedom: P - and Q -control for each phase. The six control degrees are applied to a distribution static compensator (D-STATCOM): (i) to support the AC voltages against voltage droop arising from weak transmission lines; (ii) to balance the active and reactive powers at the sending-end although the three-phase load is unbalanced; and (iii) to balance the voltages across the unbalanced load. A second contribution is a method to suppress DC voltage imbalance of D-STATCOM capacitors caused by zero sequence transients. Proof of concept is by simulations. The simulation tool used is EMTDC-PSAD.

Nomenclature

List of abbreviations

AC	alternating current
SPM	single phase active power measurement
DC	direct current
IGBT	insulated gate bipolar transistor
PLL	three-phase phase-locked loop
PCC	point of common connection
S-PLL	single-phase PLL
exp	exponential function
FACTS	flexible AC transmission system
Im	imaginary part of complex number
D-STATCOM	distribution static compensator
LPF	low pass filter
VSC	voltage source converter
rms	root mean square
SPWM	sinusoidal pulse-width modulation
PI	proportional-integral controller
HVdc	high voltage direct current

Symbols with subscripts or superscripts

$v(t)/V/\bar{V}$	instantaneous value/rms/phasor of voltage
\bar{S}	apparent power
$i(t)/I/\bar{I}$	instantaneous value/rms/phasor of current
P	active power
I_p	current component which is in-phase with phase voltage
Q	reactive power
I_q	current component which is in-quadrature with phase voltage
Z	impedance

$M(t)$	modulation signal of SPWM
f	frequency
$m(t)$	compensated modulation signal of SPWM
θ	phase angle
ΔV	perturbation voltage
ε	error signal
$C(t)$	reference current of the VSC

Subscripts and superscripts

$+/-/0$	positive/negative/zero sequences
$a/b/c$	a -phase/ b -phase/ c -phase in abc frame
d/q	d axis/ q axis in dq frame
$V-a, V-b, V-c$	voltages of a -, b - and c -phase
*	controlling variable
T_a, T_b, T_c	a -, b - and c -phase of transmission lines
N	neutral wire
L_a, L_b, L_c	a -, b - and c -phase of load
ave	average value
S_a, S_b, S_c	a -, b - and c -phase of sending-end side
Loss	VSC losses
C_a, C_b, C_c	a -, b - and c -phase of D-STATCOM
dc	VSC DC link
U	upper bus of DC link
Tri	triangle carrier
L	lower bus of DC link
REF	reference values

Other symbols

ω	radian frequency
j	imaginary axis in apparent plan
K_p	proportional gain
K_i	integral gain