

**TRANSFORMERLESS PHOTOVOLTAIC INVERTER  
FOR PHOTOVOLTAIC POWER GENERATION IN PERLIS  
TO RUN HIGH AC LOAD**

**MUHAMMAD IRWANTO BIN MISRUN**

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**UNIVERSITI MALAYSIA PERLIS  
2012**



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FOR PHOTOVOLTAIC POWER GENERATION IN PERLIS  
TO RUN HIGH AC LOAD**

by

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## LIST OF SYMBOLS, ABBREVIATION OR NOMENCLATURE

AC	Alternating Current
CERE	Centre of Excellence for Renewable Energy
CRM	Coefficient of Residual Mass
CTHD	Current Total Harmonic Distortion
DC	Direct Current
NSE	Nash-Sutcliffe equation
PSHs	Peak Sun Hours
PV	Photovoltaic
RMSE	Root Mean Squared Error
STC	Standard Test Condition for PV module
TNB	Tenaga Nasional Berhad
$A$	An “apparent” extraterrestrial flux
$A_i$	Area of orientation surface, $i$
$a$	Empirical coefficient
$a$	The intercept point of the regression line and the y axis.
$b$	The slope of the regression line
$b$	The fit parameter of the PV model
$C$	Sky diffuse factor
$D$	The diffusion coefficient

$DF$	Eccentricity correction factor of the earth's orbit
$e$	Percentage error
$E_{\text{solar},i}$	Available solar radiation on different orientation surfaces
$f$	Utilization factor
$FF$	Fill factor of PV module
$H$	Hour angle
$I_b$	Translation of direct-beam irradiance
$I_t$	Total solar irradiance
$I_{bt}$	Total beam solar irradiance
$I_{dt}$	Total diffuse solar irradiance
$I_{rt}$	Total reflected solar irradiance
$I_{SC}$	Short circuit current of PV module
$I_{\text{max}}$	Maximum current of PV module
$I_{MPP}$	Current of PV module in the maximum power point STC
$I(\alpha, T, V)$	The circuit current as function of solar irradiance, temperature
$J_s$	The saturation current density
$k$	Optical depth
$m$	Air mass ratio
$n$	Day number
$n_i$	The intrinsic carrier density

$N$	Number of elements
$P_{\max}$	Maximum power of PV module
$P_T$	Theoretical power of PV module
$p_{n0}$ and $n_{p0}$	Electron and hole densities in n-type region and p-type region at thermal equilibrium
$R_S$	Solar radiation
$R_a$	Extraterrestrial radiation
$R_{Sest}$	Daily estimated solar radiation
$R_{Smea,i}$	The measured daily solar radiation at i day
$R_{Sest,i}$	The estimated daily solar radiation at i day
$\overline{R_{Smea}}$	The average measured solar radiation
$SC$	Solar constant
$T_{\max}$	Maximum air temperature
$T_{\min}$	Minimum air temperature
$T_d$	Difference between maximum and minimum air temperature
$T_N$	Nominal temperature (25 °C)
$TC_i$	Temperature coefficients of the short circuit current of PV module
$TC_v$	Temperature coefficients of the open circuit voltage of PV

	module
$TD_{sqr1}$	Time delay of the first pulse
$TD_{sqr2}$	Time delay of the second pulse
$V_{OC}$	Open circuit voltage of PV module
$V_{min}$	Minimum voltage of PV module
$V_{max}$	Maximum voltage of PV module
$V_{MPP}$	Voltage of PV module in the maximum power point STC
$V_{oc}(\alpha, T)$	The open circuit voltage as function of solar irradiance and temperature
$V_1$	The amplitude of the fundamental voltage harmonic
$V_{rms}$	rms value of the voltage waveform generated
$V_n$	$n$ th voltage harmonic
$W_s$	Mean sunrise hour angle
$x$	The first variable
$y$	The second variable
$\beta$	Zero voltage angle of three level AC waveform
$\beta_N$	Angle between the sun and the local horizontal directly beneath the sun
$L$	Latitude of the site
$\delta$	Solar declination

$\gamma$	Tilt angle of PV module
$\theta$	Angle of incidence between a line drawn normal to the PV module face and the incoming beam irradiance
$\phi_p$	Azimuth angle
$\phi_s$	Solar azimuth angle
$\rho$	Reflectance
$\eta_{pv}$	Efficiency of PV modules
$\eta_m$	Maximum efficiency of PV module
$\eta_i$	The ratio between the power in the fundamental ( $V_1^2 / 2$ ) and the power in the AC waveform
$\alpha$	Maximum voltage angle of three level AC waveform
$\alpha_{min}$	Minimum solar irradiance
$\alpha_{max}$	Maximum solar irradiance
$\tau$	The minority lifetime