

Mitigation of Harmonics for Residential Loads by Shunt Active Power Filter using SRF Theory

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Article Info

Volume 82

Page Number: 8295 - 8300

Publication Issue:

January-February 2020

Article History

Article Received: 18 May 2019

Revised: 14 July 2019

Accepted: 22 December 2019

Publication: 07 February 2020

Abstract:

With the fast rise of depth digital devices in mechanical, commercial enterprise and private purposes have prompted disappointment of deliver voltage and current waveforms which causes electricity quality problems inside the stock framework. Demonstrating of numerous nonlinear loads, as an example, PC, fluorescent light, customizable velocity power, uninterruptible pressure deliver with and with out Shunt dynamic pressure channel (SAPF) is carried out to relieve contemporary tune within the flow framework in this paper. The showing and reenactment is finished in MATLAB/SIMULIN.

Keywords: Shunt active power filter (SAPF), Power quality, Non-Linear Loads, Total harmonic distortion (THD).

I. INTRODUCTION

Electrical utilization is conspicuous inside the day by day way of lifestyles nowadays. The showing of sounds developing loads i.e., nonlinear burdens which can be utilized for family/business motives for present is portrayed in [2]. The modern-day song in addition to voltage song that are produced by way of non direct loads aggravates the pressure first-rate. Along these lines, these contemporary/voltage sounds must be alleviated. For this dynamic and indifferent channels were proposed.

Traditionally, uninvolved channels, comprising of tuned LC excessive latent channels are utilized to alleviate sounds as much as certain degree and capacitors are applied to improve the pressure factor [3].

Dynamic pressure channels are considered as feasible option over the antique fashion aloof channels, to remunerate supply modern-day sounds added with the aid of the non-instantly masses [3]. The goal of the dynamic keeping apart is to fulfill the responsive pressure want and maintain up the sounds as in line with IEEE Std. 519-1992 [4]. Shunt

Active Power Filter (SAPF) can be utilized with diverse current manage structures, for instance, Synchronous reference define method, Instantaneous receptive pressure hypothesis, Unit vector layout method, Fuzzy reason controller, neural systems. Each control method has its very personal factors of hobby and detriments in reducing the tune from the framework [5]. The paper predominantly centers round Synchronous Reference Frame (SRF) hypothesis which decreases the song under diverse supply voltage conditions. For age of entryway beat indicators Hysteresis Current Controller (HCC) is utilized that are given to force the Switches of the Shunt Active Power Filter and infuse the important pay signal. Corresponding Integral controller is utilized to remunerate the misfortunes of the SAPF.

II. SHUNT ACTIVE POWER FILTER (SAPF)

For compensating current harmonics shunt active filter is used which injects Current in phase opposition to the harmonics current which depends on the reference current generation [1].

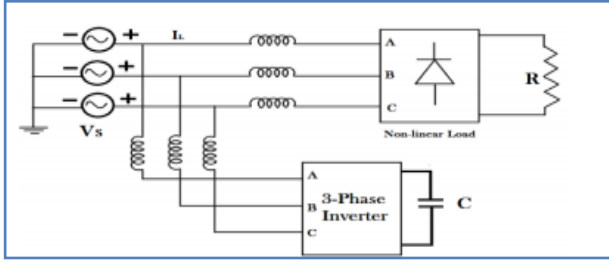


Fig.1. Three Phase Shunt Active Power Filter

A. REFERENCE CURRENT GENERATION BY SRF THEORY:

The primary approach for growing reference present day is SRF method in which load current in a-b-c fixed casing is modified in to d-q pivot segments so it is whatever however tough to mild consonant substance in load modern-day with an assistance of a low skip channel. A schematic outline of SRF method is seemed in discern 2.

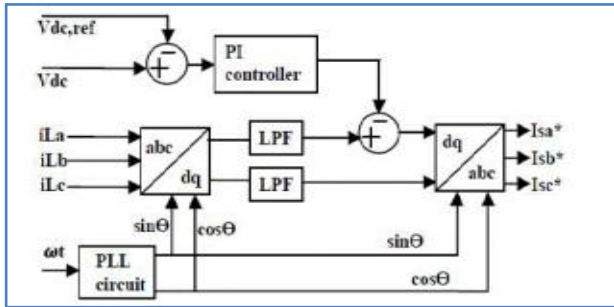


Fig.2. SRF Method for reference current generation

For synchronization purpose to provide as fundamental frequency a phase locked loop (PLL) is used. To maintain DC link capacitor voltage constant a PI controller is used. By using Park's transformation, Load current in a-b-c frame is transformed in to 0-d-q frame component defined as

$$\begin{bmatrix} iq \\ id \\ io \end{bmatrix} = \frac{2}{3} \begin{bmatrix} \cos \theta & \cos(\theta - 2\pi/3) & \cos(\theta + 2\pi/3) \\ \sin \theta & \sin(\theta - 2\pi/3) & \sin(\theta + 2\pi/3) \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} ia \\ ib \\ ic \end{bmatrix} \quad (1)$$

By using Inverse Park's transformation 0-d-q frame component is transformed in to a-b-c frame component to get reference compensating current defined as

$$\begin{bmatrix} ia \\ ib \\ ic \end{bmatrix} =$$

$$\begin{bmatrix} \cos \theta & \sin \theta & 1 \\ \cos(\theta - 2\pi/3) & \sin(\theta - 2\pi/3) & 1 \\ \cos(\theta + 2\pi/3) & \sin(\theta + 2\pi/3) & 1 \end{bmatrix} \begin{bmatrix} iq \\ id \\ io \end{bmatrix} \quad (2)$$

B. Hysteresis Band Current Regulator:

For generating the pulses in current controlled, hysteresis band current regulator (HBCC) technique is used. The control technique is a simple method for providing quick response, with better accuracy and good stability.[1]. It consists of a hysteresis band which surrounds the created error current. By subtracting the actual filter current from the reference current error is generated. For acquiring the switching pulses to the inverter the error signal is given to the relay with the preferred hysteresis band. The reference current, actual filter current is denoted as i_{abc}^* , i_{fabc} .

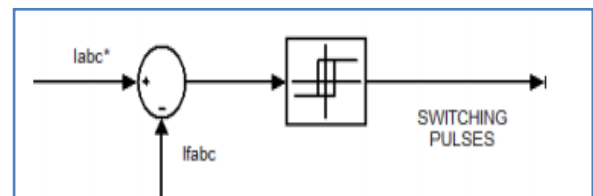


Fig.3. Hysteresis Band Current Control

III. NONLINEAR LOADS

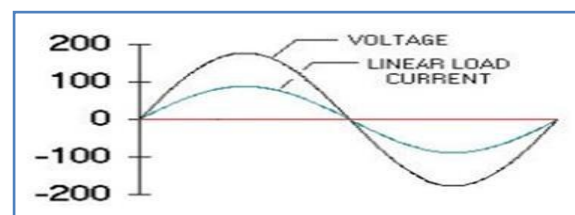


Fig.4. Characteristics of Linear Loads

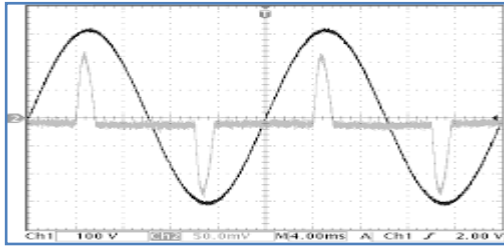


Fig.5. Characteristics of Nonlinear Loads

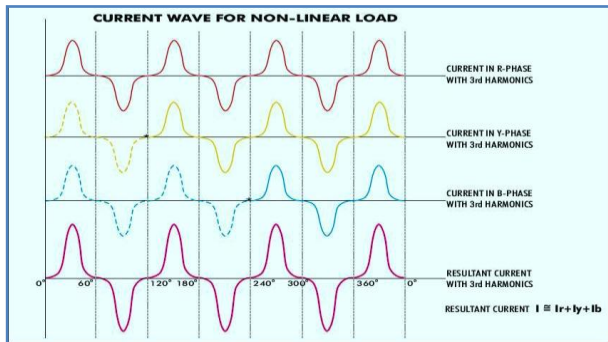


Fig.6. Current waveforms for 3-phase system

A. PERSONAL COMPUTER (PC):

PC load is modeled using SMPS and it consists of a full wave rectifier, a diode bridge resistance R , a DC storage capacitor C and series RFI choke denoted by an inductance L . The input power supply which is ac voltage at 50 Hz is converted to a desired DC output voltage by means of a single-phase rectifier circuit to feed it to the PC load.

B. COMPACT FLUORESCENT LAMP:

Compact fluorescent lamps (CFLs) are step by step being utilized in private and business structures on account of the advantages that they diminish the power utilization.

C. Uninterruptable power supply (UPS):

From input power disturbances to provide instant protection by means of one or more batteries and related electronic circuitry, diesel generators for low power users and flywheels for high power users.

D. Adjustable Speed Drive (ASD):

ASD's consists of an induction motor supplied by variable AC voltage. It consists of 6 or 12 pulse rectifier, the inverter and frequency to regulate the speed of the motor.

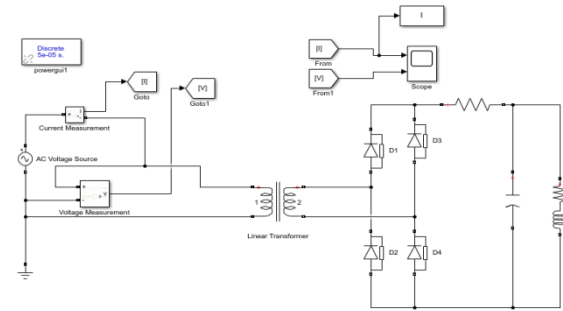


Fig.7. Simulink Model for PC Load

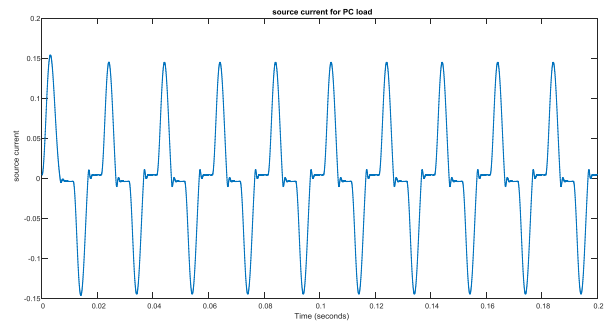


Fig.7a. Source Current Waveform for PC Load

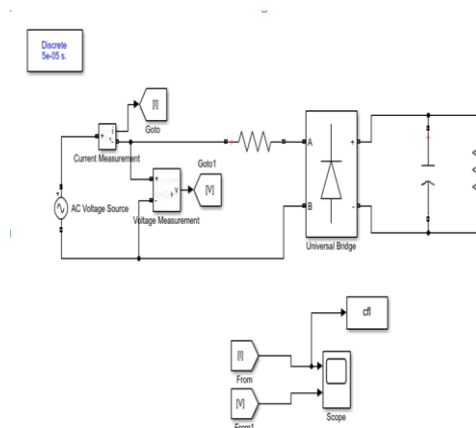


Fig.8. Simulink Model for CFL Load

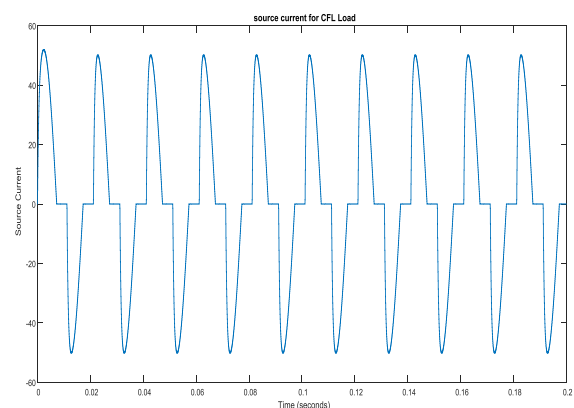


Fig.8a. Source Current Waveform for CFL Load

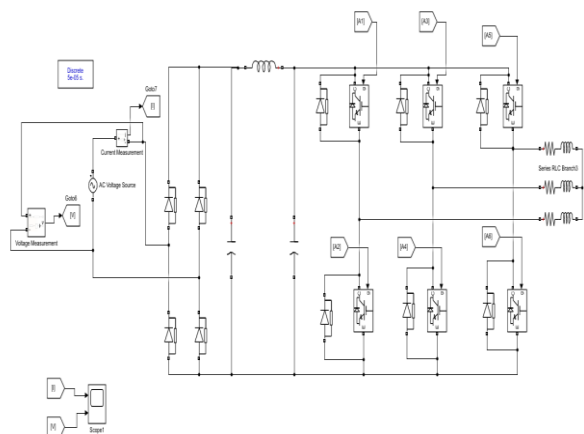


Fig.9. Simulink Model for UPS Load

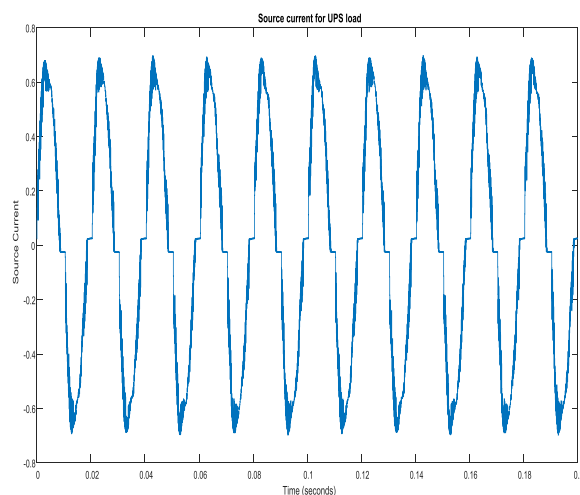


Fig.9a. Source Current Waveform for UPS Load

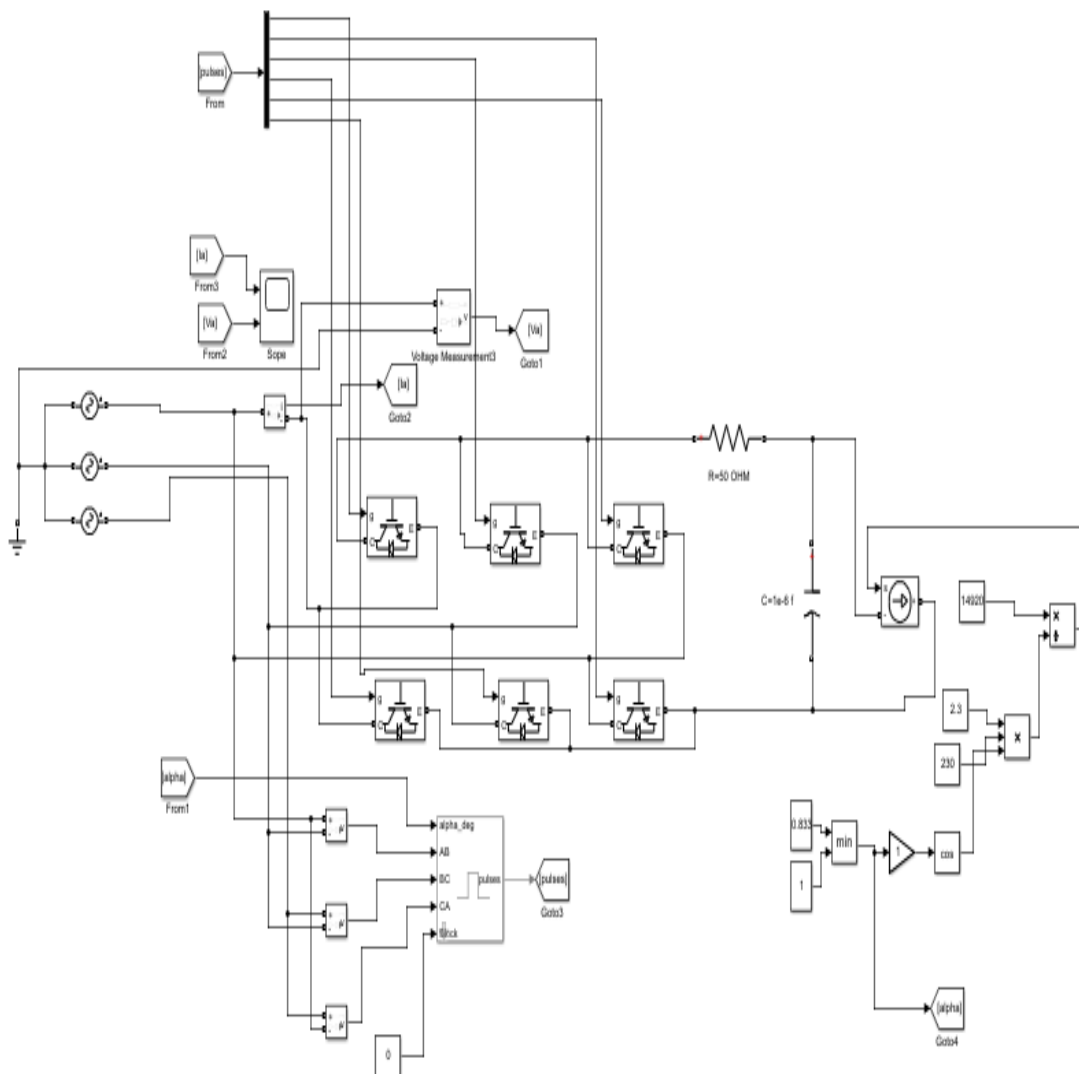


Fig.10. Simulink Model for ASD Load

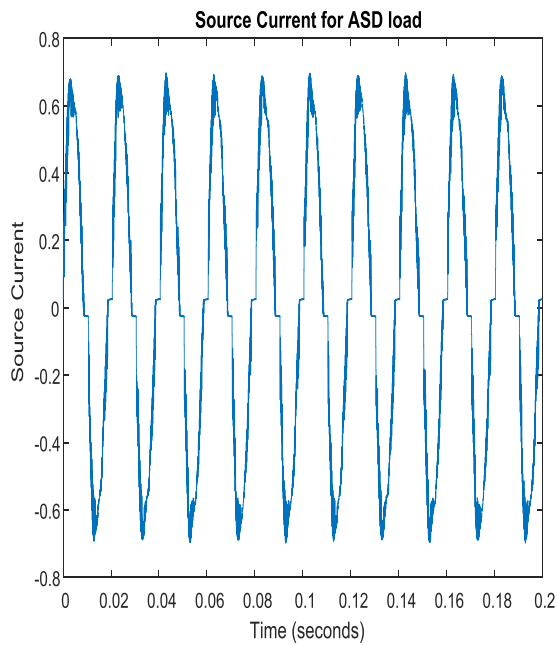


Fig.10a. Source Current Waveform for ASD Load

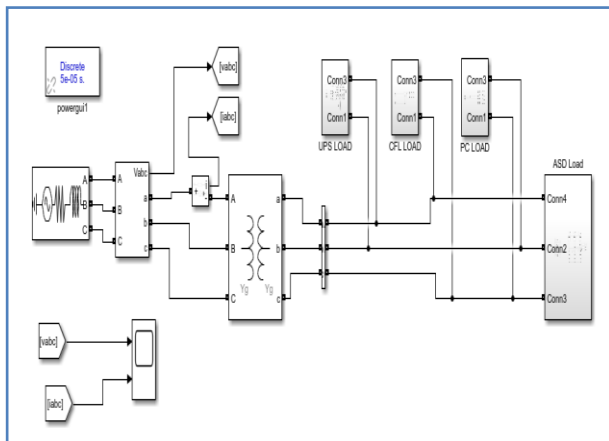


Fig.11. Simulink Model of Electrical load Distribution system without SAPF

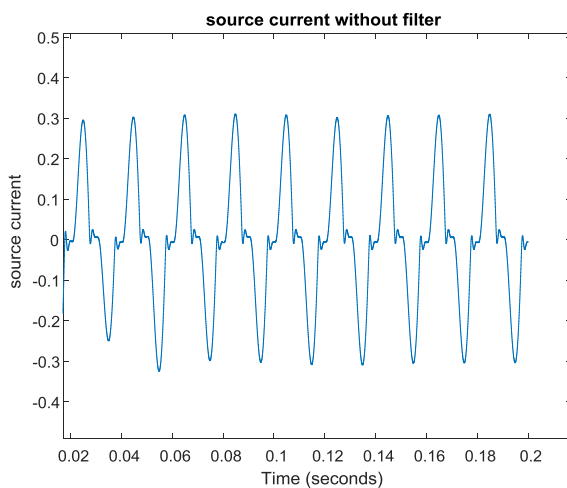


Fig.11a. Source Current without SAPF

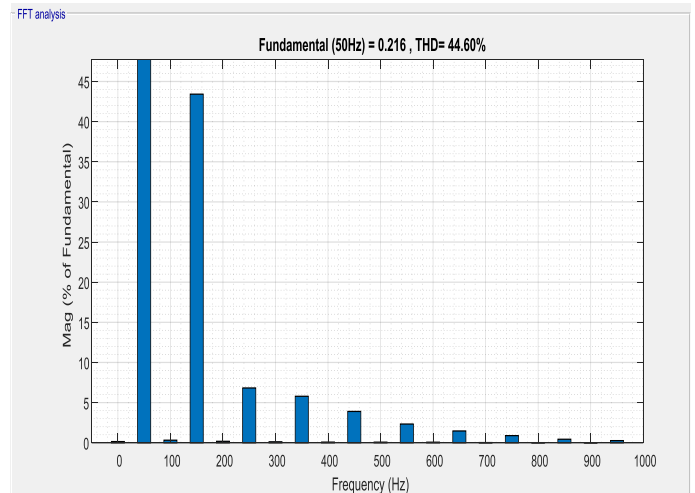


Fig.12. THD for Source Current without SAPF

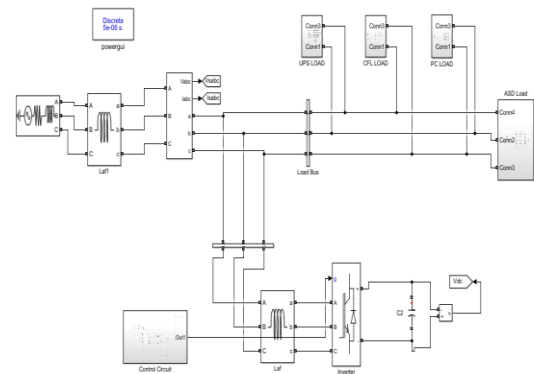


Fig.13. Simulation Model with SAPF

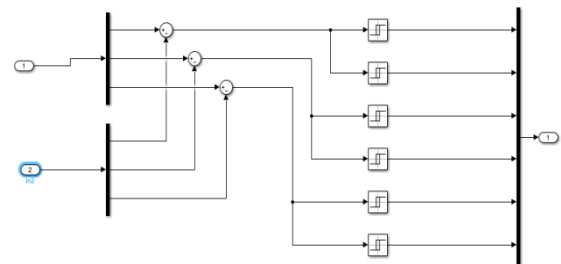


Fig.13a. Simulink Model of Hysteresis Band Current Control for pulse generation

Fig.13b. Source Current with SAPF

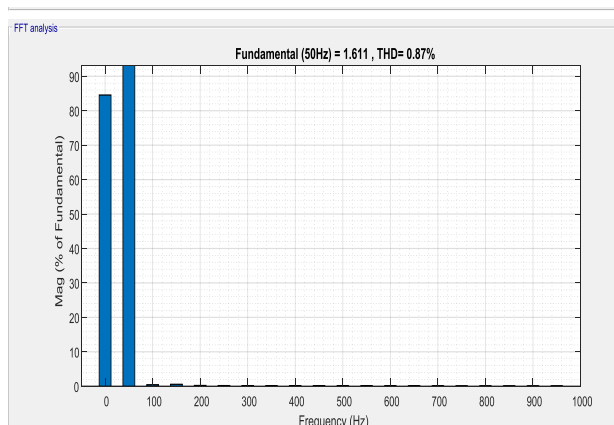


Fig.14. THD of Source Current with SAPF

Table1 below shows %THD of source current without and with shunt active power filter.

	THD Without SAPF	THD With SAPF
Source Current (I_s)	44.60%	0.87%

Table 1: %THD of source current without and with SAPF

CONCLUSION

In this paper Simulation models of diverse nonlinear burdens which may be carried out for each non-public and organisation packages are added and genuinely the consonant twisting is determined. Displaying and duplicate of various non direct loads with and without Shunt dynamic force channel is achieved and THD's are analyzed. By means of using shunt dynamic pressure channel THD level is dwindled. From the above discoveries SAPF can be carried out to relieve the current sounds.

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