3) the superimposed current is detected within a defined time window after fault inception. The relay will not respond to any disturbance outside this window. By this arrangement, the superimposed currents due to switching and energization generated are effectively excluded;
4) the proposed technique cannot detect the operation of the remote circuit breaker (CB) when one of the parallel lines is out of service. In this case, the “Instant” or “Delayed” operation scheme can be adopted depending on the fault types;
5) the algorithm is used in connection with the phase selection algorithm of the relay; therefore, the decision will be made after receiving information about the fault type from the phase selector.
6) the discussers clearly picks up a crucial point. Due to the mutual coupling between the two circuits, the protection algorithm will meet a problem for this extreme case of a single phase fault close to the remote busbar. In this case, the comparison of the levels of SI currents and the ratios between the two circuits is able to determine the faulted circuit;
7) the algorithm has not been tested with any evolving fault case. The authors do agree and have a plan to perform such tests;
8) simulation studies show that the technique performs reliably for most fault conditions. Initial studies also show that the disconnection of the source at busbar R has little effect on the performance.

Discussion of “An Evaluation of Some Alternative Methods of Power Resolution in a Large Industrial Plant”
F. de León and J. Cohen

The authors have presented another comparison of some of the most popular definitions for power under nonsinusoidal conditions. There is already a long list of publications showing the benefits and drawbacks of the definitions compared in the paper; for example see [1]. The value of the paper is that it allows the opportunity of reopening an important unfinished discussion.

We will show, with a very simple example, that the power definitions compared in this paper are all erroneous. Consider a single-phase half-wave controller (thyristor-diode) feeding a pure resistive load. The thyristor’s firing angle has been adjusted to give the current waveshape of Fig. 1. The time domain expressions for voltage and current are

\[ v(t) = \sqrt{2}(13)\sin(\omega t) \]
\[ i(t) = \begin{cases} 0 & 0 \leq \omega t < \frac{\pi}{2} \\ \frac{10}{\sqrt{2}} \sin(\omega t) & \frac{\pi}{2} < \omega t \leq 2\pi \end{cases} \]  

The Fourier analysis of these functions yields is shown in Table 1.

<table>
<thead>
<tr>
<th>Harmonic Order</th>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$</td>
<td>V</td>
</tr>
<tr>
<td>0</td>
<td>169.7</td>
<td>-13.50474</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>-0.209105</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2.677945</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>1.570796</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0.244979</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>4.712389</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

We cannot easily accept, as claimed by the authors, that the calculated reactive power for this example “is an indication of the energy stored in magnetic and electrostatic fields.” There are no reactive components.
capable of storing power in this network. The load is purely resistive. Would the authors comment on this?

We believe that the source of the problem (for most of the available power definitions) is that Fourier analysis has been used to extend the power theory for the linear case to the nonlinear case. When using Fourier analysis to solve the circuit, we find an infinite number of mathematical (nonphysical) harmonic currents. For $0 < \omega t > \pi/2$, the currents add perfectly to zero. How can (harmonic) currents flow when the circuit is actually open? Thus, the powers derived from them cannot have a true physical significance. See [2] for examples where no physical meaning could be found to $D$.

Fryze’s model fails to give the proper physical meaning because the instantaneous current was divided (active and inactive) instead of dividing the voltage. The active component is equal (for this example) to the fundamental in the Fourier sense. The dual to Fryze’s model, presented in [3], gives the correct physical meaning. Our model is consistent with Poynting and Tellegen Theorems. The consumption (or active) component is derived from the application of Joule’s Law $a(t) = (P/\text{I} \text{rms}^2) j(t)^2$.

Fryze’s model has been interpreted as the projection of the current over the voltage [4]. Fryze projects an infinite-dimensional vector over a one-dimensional (1-D) vector; therefore, vital information is lost. We project the voltage (1-D) over the current (infinite-dimensional).

Figs. 2 and 3 compare the instantaneous active and reactive powers for the different definitions. Note that while all of the active power definitions have the same average $P$, only our $a(t)$ is equal to $p(t)$. Similarly, while all the models have a zero average reactive power, only our model gives zero for the entire period. This is consistent with the load characteristics. The authors’ comments would be appreciated.

REFERENCES