ARTICLE

What Are Harmonics?

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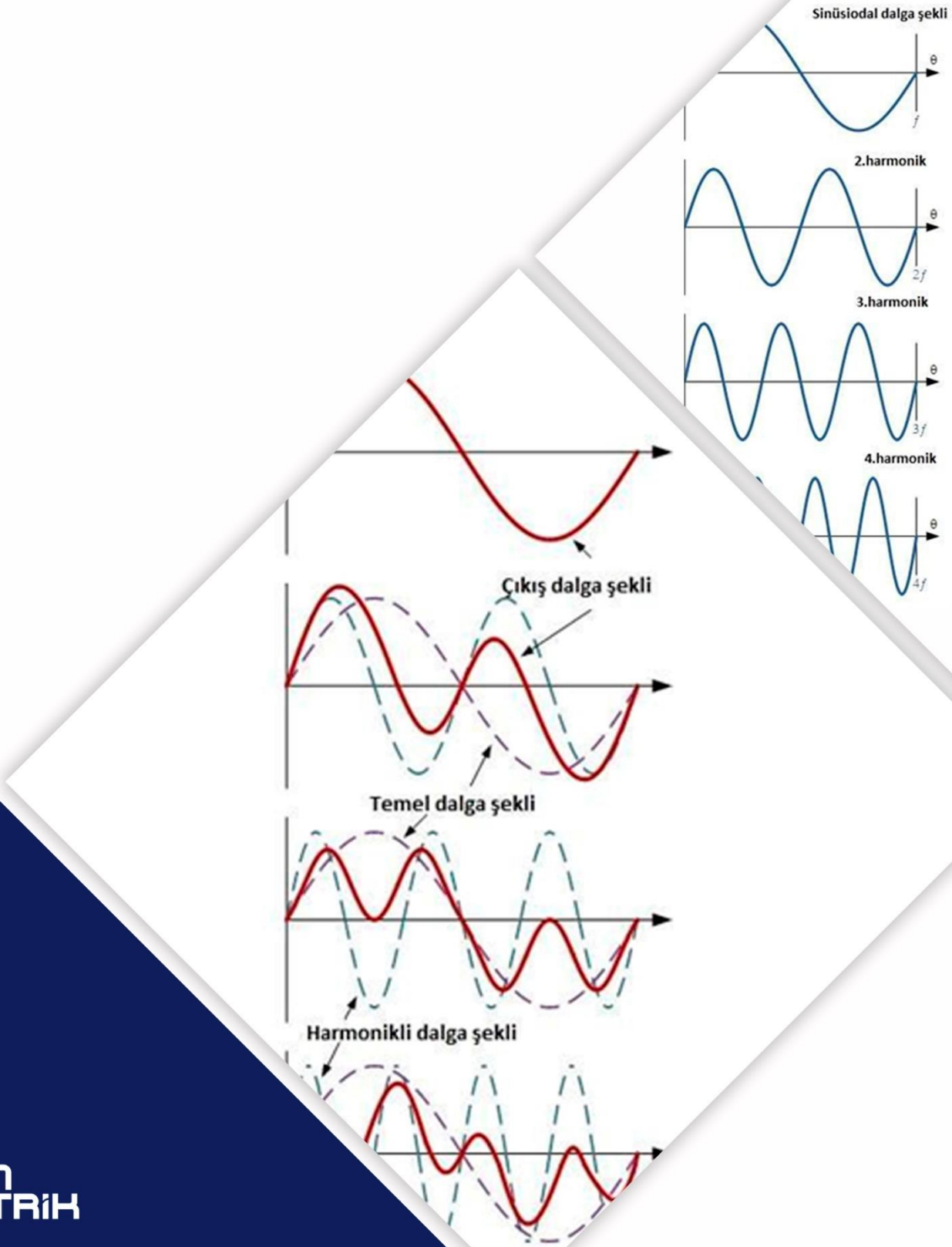
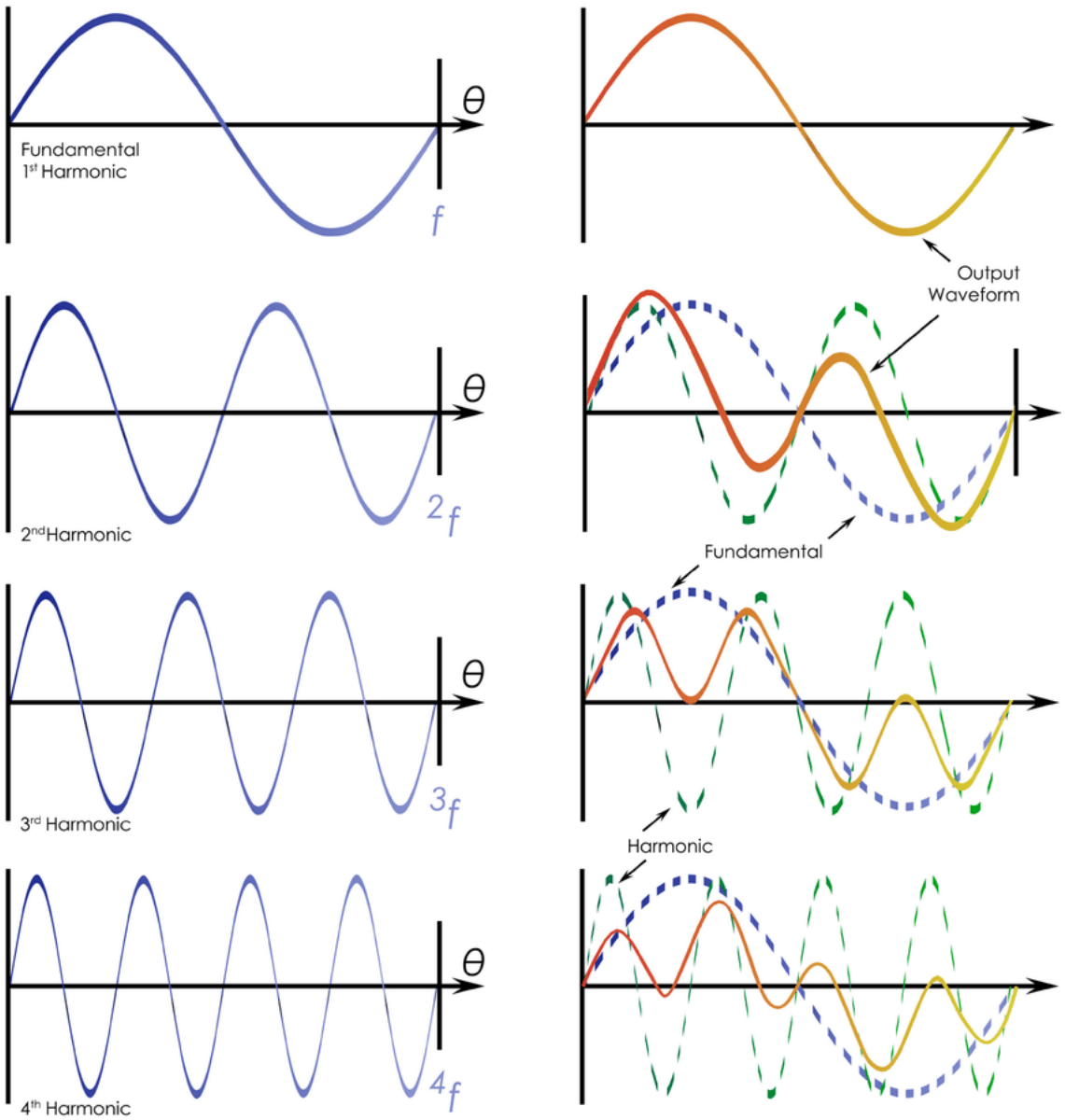


ERGUN ELEKTRİK

WHAT ARE HARMONICS?

Harmonic frequencies are multiples of the mains frequency. For instance, the third harmonic for a fundamental frequency of 50Hz is 150Hz, and the fifth harmonic is 250Hz. Harmonics manifest as current harmonics, flowing through subcircuits to create voltage harmonics. In calculations and measurements, those in the frequency range of 100-Hz (2nd harmonic) to 2.5-kHz (50th harmonic) are considered. The range from 2.5kHz to 150kHz is termed supraharmonic. Harmonics cause deviations from ideal sinusoidal waveforms in both current and voltage, as depicted below.



Harmonic currents and voltages occur when non-linear loads are connected to the electrical grid.

In recent years, there has been a significant increase in scientific studies on intermediate harmonics. Harmonics are defined as frequencies that are integer multiples of the city grid frequency, and those in the range of 100 Hz (2nd harmonic) to 2.5 kHz (50th harmonic) are considered in calculations and measurements. The range from 2.5 kHz to 150 kHz is referred to as supraharmonics. Network harmonics can be detected by measurements taken with a power quality device, where current harmonics measured are indicated as THDi, and voltage harmonics as THDu.

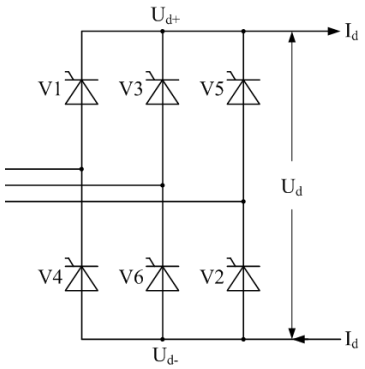
Linear Loads :

- Ohmic Loads, resistors
- Asynchronous motor
- Capacitors

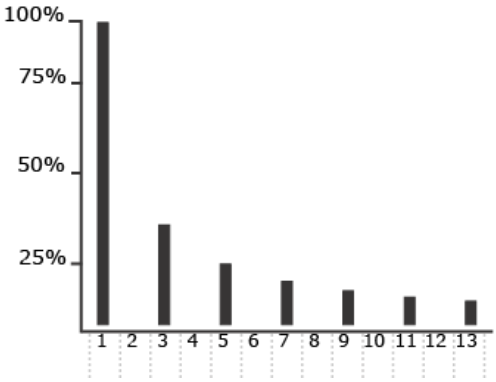
Nonlinear loads can cause the voltage and current waveshape to deviate from their ideal form.

- Uninterruptible power supplies ve IT loads
- Variable Frequency Drives
- Rectifier circuits
- Thyristor-controlled circuits
- Arc furnaces
- Welding machines
- Transformers operating in the saturation region
- Transformers loaded above their nominal Power

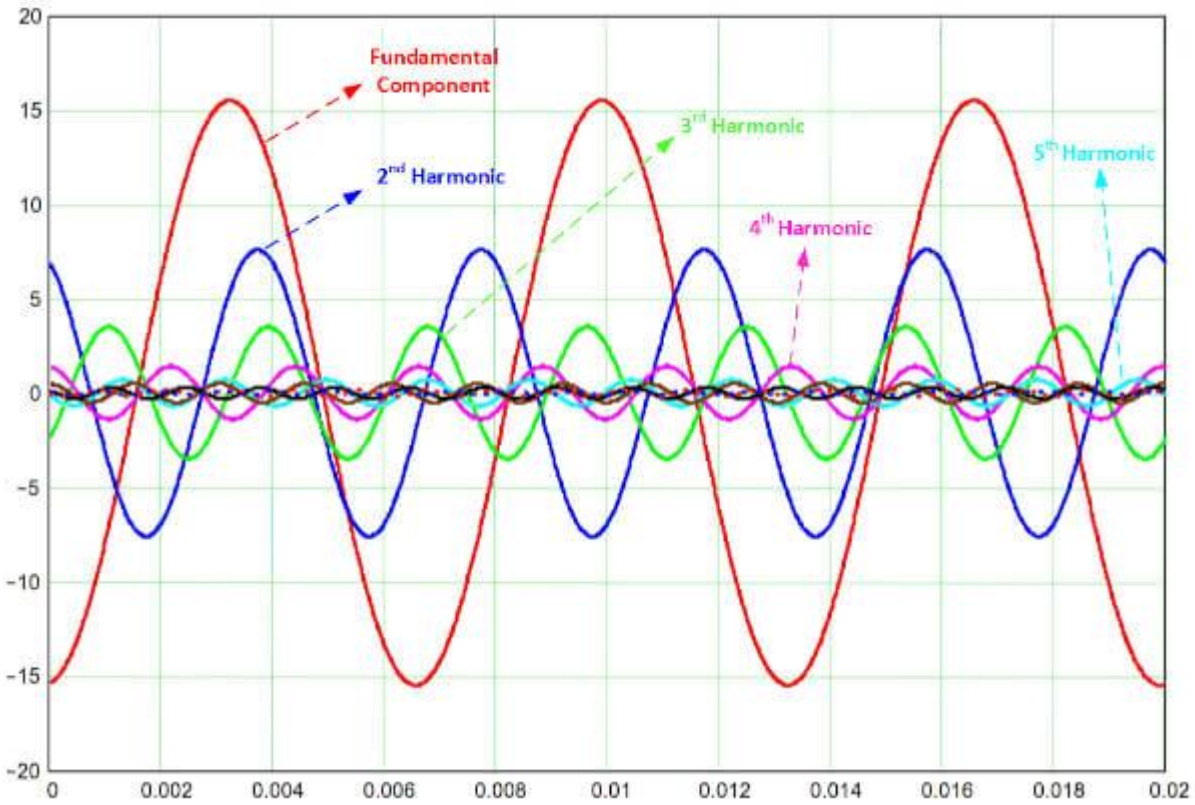
Six-pulse bridge rectifiers generate harmonics that are 6n±1, where one is more or less than a multiple of six.



Six Pulse Bridge



Harmonic Spectrum
of a Square Wave



Harmonic currents and voltages can cause problems on both the grid side and the load bus side. These include:

- Resonance can occur and damage the compensation system.
- Supply switches can trip at an unpredictable time due to resonance events, causing the plant to shut down.
- Motors and their cables can suffer from increased losses and overheating.
- Insulation can weaken and shorten the lifespan of plant components.
- The neutral cable can become overloaded, leading to overheating.
- Capacitors and related equipment can have significantly shortened lifespans.
- Measuring instruments can be prone to providing inaccurate readings.
- Control circuits operating at the zero point can malfunction.
- Transformers and asynchronous motors are prone to overheating.
- Losses can rise . $S = \sqrt{(P2 + Q2 + D2)}$ D: Harmonic Distortion

Each consumer connected to the grid produces harmonics with linear loads, and these currents flow into the grid in proportion to the source impedance. This leads to harmonic voltage distortion at the point of connection. The higher the harmonic current produced by consumers, the greater the ratio of harmonic voltage distortion will be at the PCC point. Essentially, each user adds an additional harmonic contribution to the grid.

To prevent pollution of the grid by harmonics, general harmonic standards have been published. Businesses that exceed these standard limit values must reduce their levels below those limits.

Various power quality solutions are available for suppressing harmonics generated by different loads, depending on their source. These solutions can effectively eliminate events and problems caused by system harmonics after suppression

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