

Total Demand Distortion (TDD)

Definition - Total demand distortion, or TDD, is the per-phase harmonic current distortion against the full load demand of the electrical system. It is expressed as a percentage and indicates the impact of harmonic distortion in the system.

Harmonic distortion occurs when there are nonlinear loads connected to a power system. Nonlinear loads draw nonlinear currents from the power grid. These non-sinusoidal currents can introduce harmonics into a power system, causing voltage and current waveforms that deviate from their ideal shape.

When considering current harmonics, we cannot rely on the total harmonic distortion (THD) index as the fundamental current changes with load variations. Load variations may be due to the load needs from differences in the season, time of day, or action within a process.

Total demand distortion can be mathematically calculated using the following formula:

$$TDD = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + \dots}}{I_L} \times 100$$

Where I_L is the RMS value of the load demand and I_n is the RMS value of the n th harmonic current.

In cases where a system shows high THD values but low demand, the impact of harmonic distortion on the system might be insignificant. At full load, the THD value for current harmonics is equal to TDD so this could negatively impact the system.

The level of total demand distortion that is considered acceptable is outlined in the IEEE standard for harmonic distortion. IEEE-519 is the IEEE Standard for Harmonic Control in Electric Power Systems. This standard provides TDD values for current at a specified point of common coupling (PCC) where other customers are or could be connected. Table 2 from the standard is shown below. Acceptable levels of TDD will vary depending on various attributes of a system.

Table 2—Current distortion limits for systems rated 120 V through 69 kV

Maximum harmonic current distortion in percent of I_L						
Individual harmonic order ^b						
I_{sc}/I_L	$2 \leq h < 11^a$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h \leq 50$	TDD
$< 20^c$	4.0	2.0	1.5	0.6	0.3	5.0
$20 < 50$	7.0	3.5	2.5	1.0	0.5	8.0
$50 < 100$	10.0	4.5	4.0	1.5	0.7	12.0
$100 < 1000$	12.0	5.5	5.0	2.0	1.0	15.0
> 1000	15.0	7.0	6.0	2.5	1.4	20.0

^a For $h \leq 6$, even harmonics are limited to 50% of the harmonic limits shown in the table.

^b Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

^c Power generation facilities are limited to these values of current distortion, regardless of actual I_{sc}/I_L unless covered by other standards with applicable scope.

where:

I_{sc} = maximum short-circuit current at PCC

I_L = maximum demand load current at PCC under normal load operating conditions