

EE 442-642

Power Conditioners and Uninterruptible
Power Supplies (UPS)

Fall 2012

Distortion in the Input Voltage

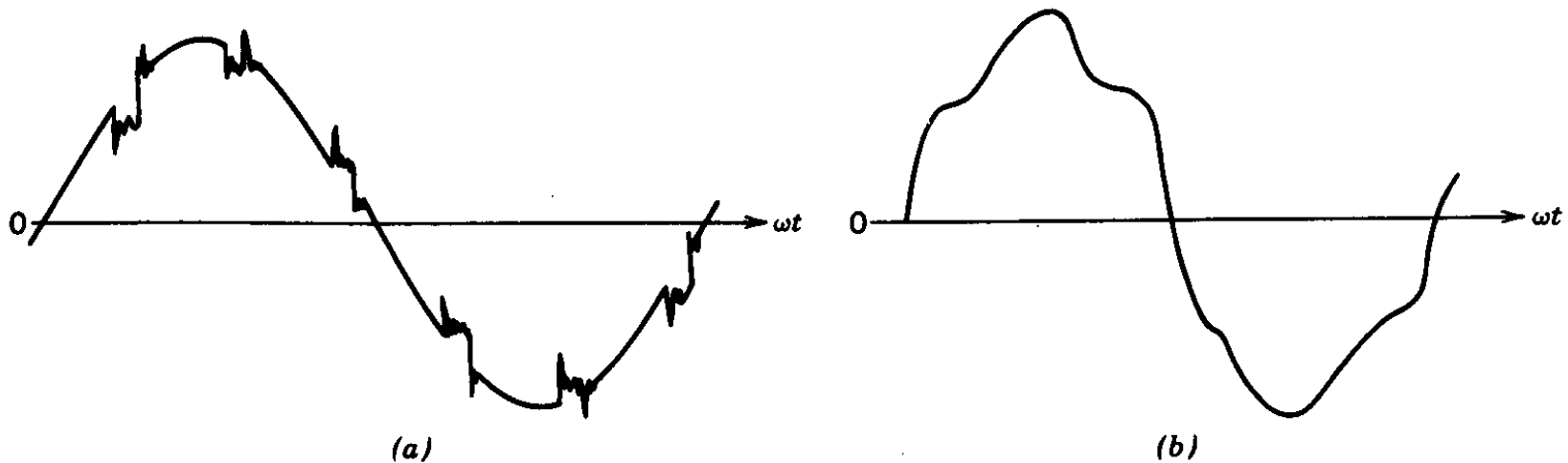
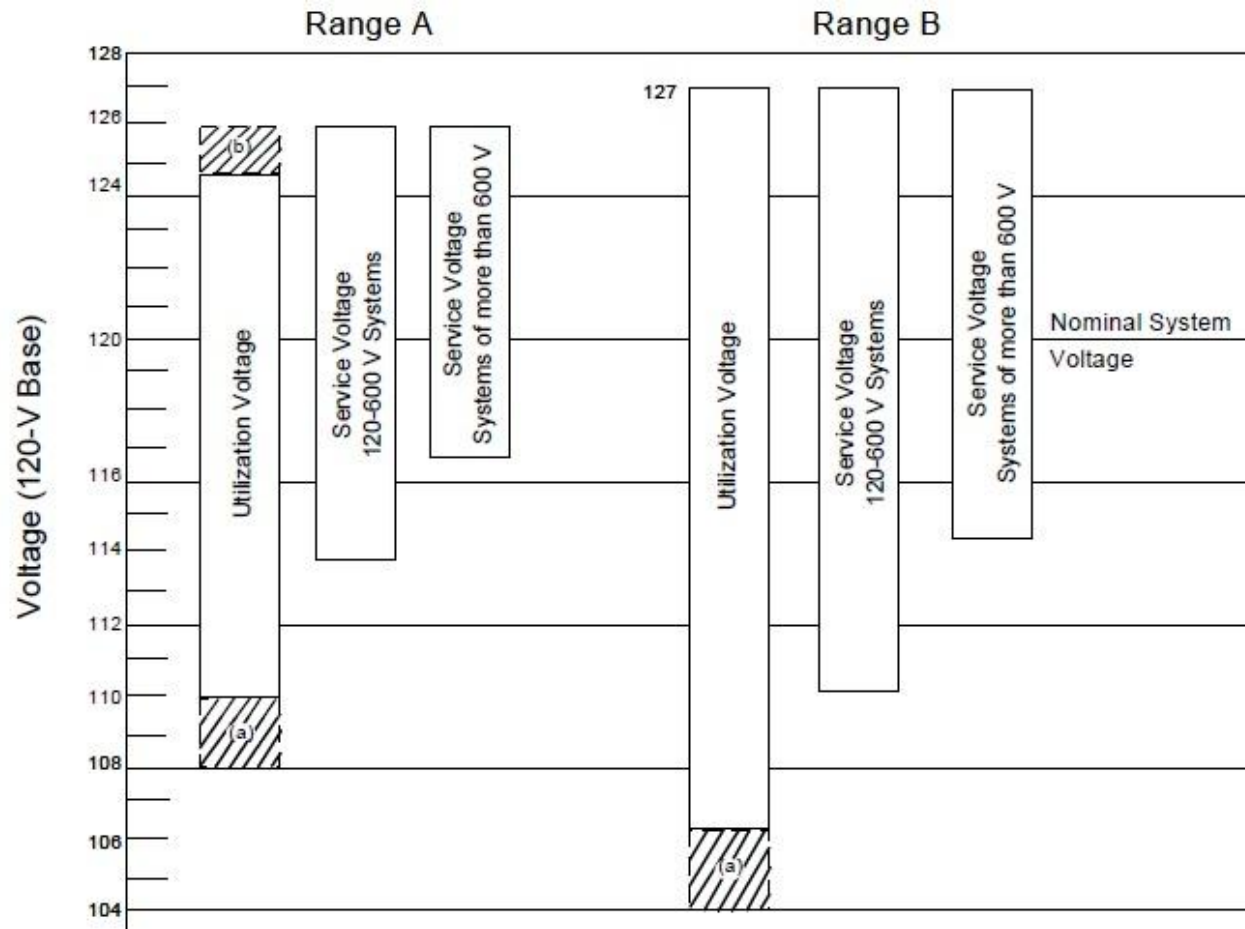


Figure 11-1 Possible distortions in input voltage: (a) chopped voltage waveform; (b) distorted voltage waveform due to harmonics.

The voltage supplied by the utility may not be sinusoidal

Voltage Tolerance Boundary: ANSI C84.1



Equipment shall be designed and rated to give fully satisfactory performance throughout this Range (A).

Although Range (B) conditions are considered part of practical operations, they shall be limited in extent, frequency, and duration.

Typical Voltage Tolerance Envelope for Computer Systems

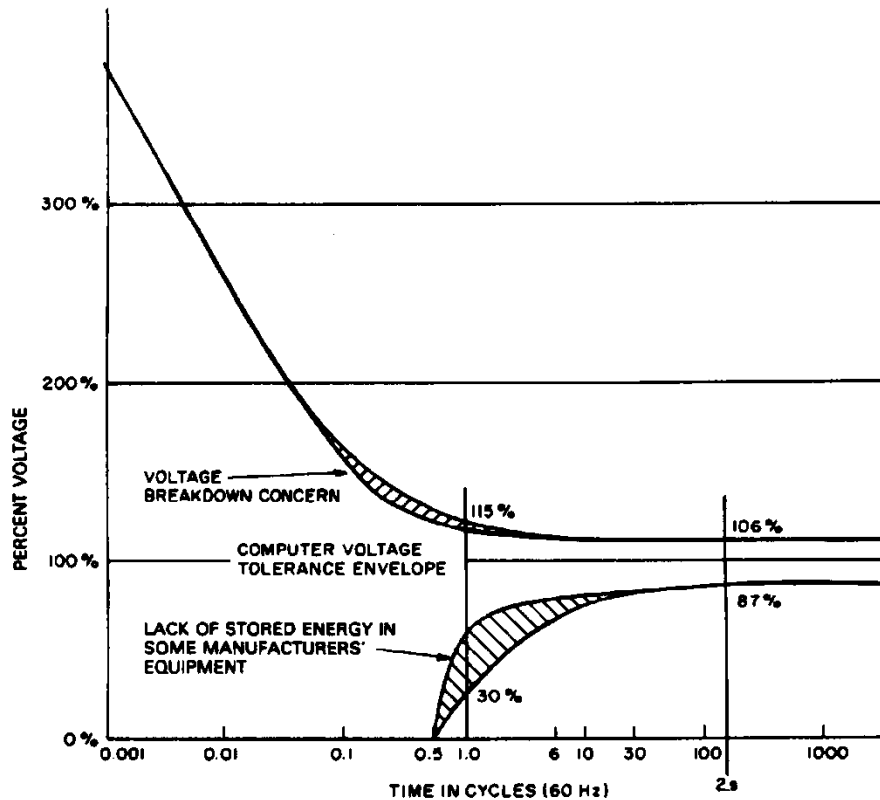
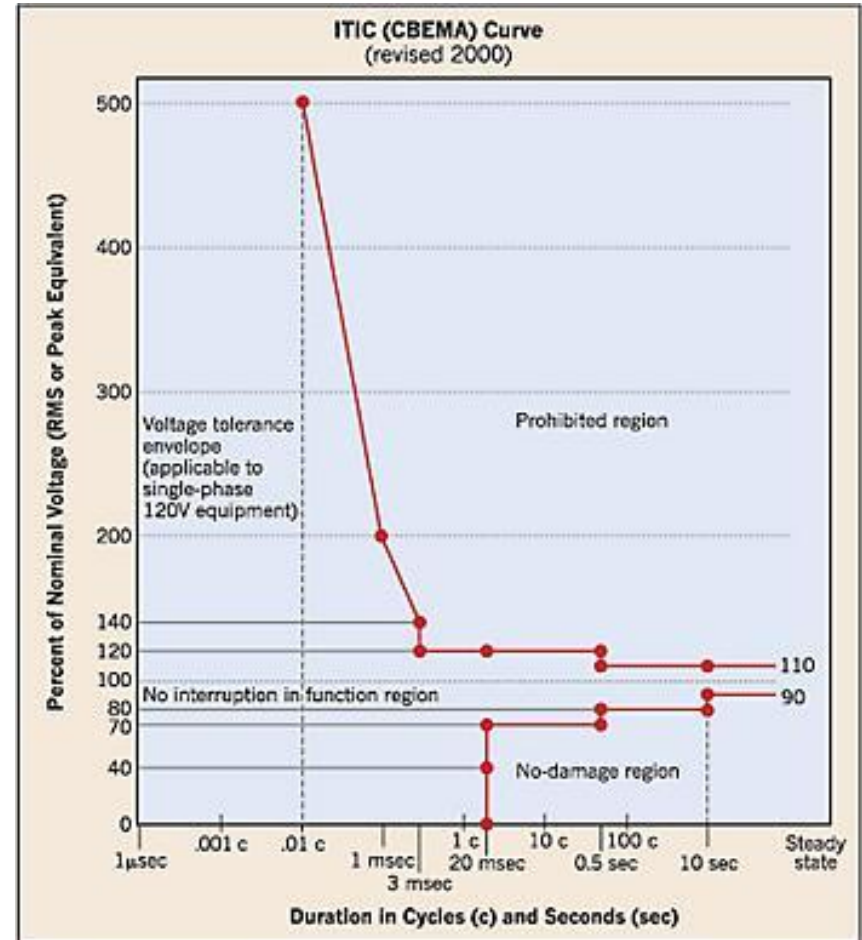


Figure 11-2 Typical computer system voltage tolerance envelope. (Source: IEEE Std. 446, "Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.")



Typical Range of Input Power Quality

Table 11-1 Typical Range of Input Power Quality and Load Parameters of Major Computer Manufacturers

<i>Parameters^a</i>	<i>Range or Maximum</i>
1. Voltage regulation, steady state	+5, -10 to +10%, -15% (ANSI C84.1—1970 is +6, -13%)
2. Voltage disturbances	
a. Momentary undervoltage	-25 to -30% for less than 0.5 s, with -100% acceptable for 4-20 ms
b. Transient overvoltage	+150 to 200% for less than 0.2 ms
3. Voltage harmonic distortion ^b	3-5% (with linear load)
4. Noise	No standard
5. Frequency variation	60 Hz \pm 0.5 Hz to \pm 1 Hz
6. Frequency rate of change	1 Hz/s (slew rate)
7. 3 ϕ , Phase voltage unbalance ^c	2.5-5%
8. 3 ϕ , Load unbalance ^d	5-20% maximum for any one phase
9. Power factor	0.8-0.9
10. Load demand	0.75-0.85 (of connected load)

^aParameters 1, 2, 5, and 6 depend on the power source, while parameters 3, 4, and 7 are the product of an interaction of source and load, and parameters 8, 9, and 10 depend on the computer load alone.

^bComputed as the sum of all harmonic voltages added vectorially.

^cComputed as follows:

$$\text{Percent phase voltage unbalance} = \frac{3(V_{\max} - V_{\min})}{V_a + V_b + V_c} \times 100$$

^dComputed as difference from average single-phase load.

Source: IEEE Std. 446, "Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications."

Electronic Tap Changers

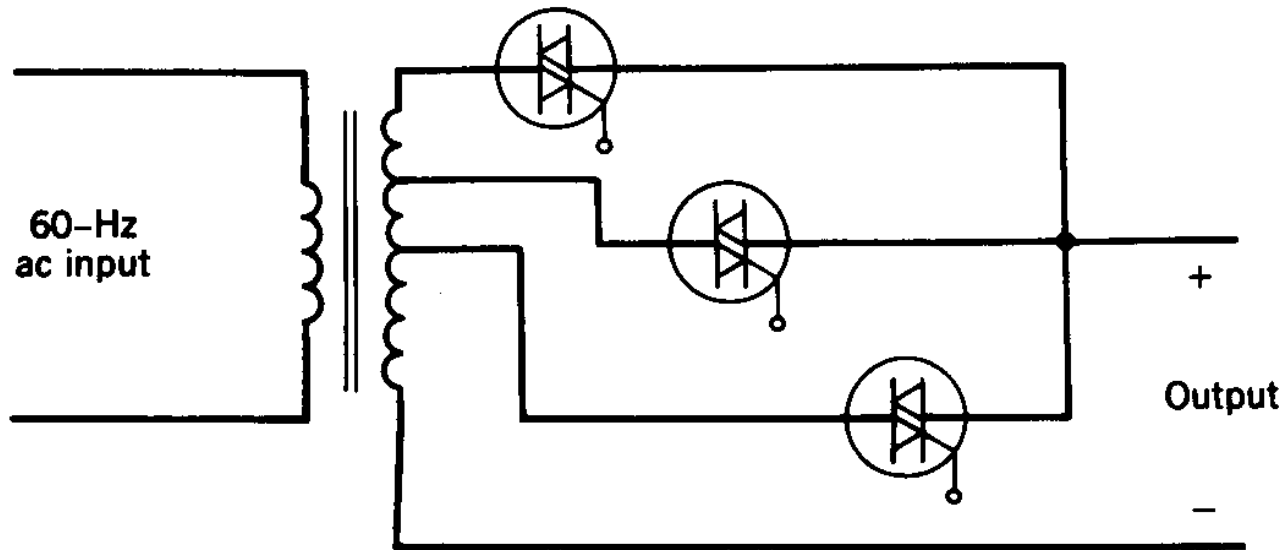


Figure 11-3 Electronic tap changer.

Controls voltage magnitude by connecting the output to the appropriate transformer tap (static tap changer)

Uninterruptible Power Supplies (UPS)

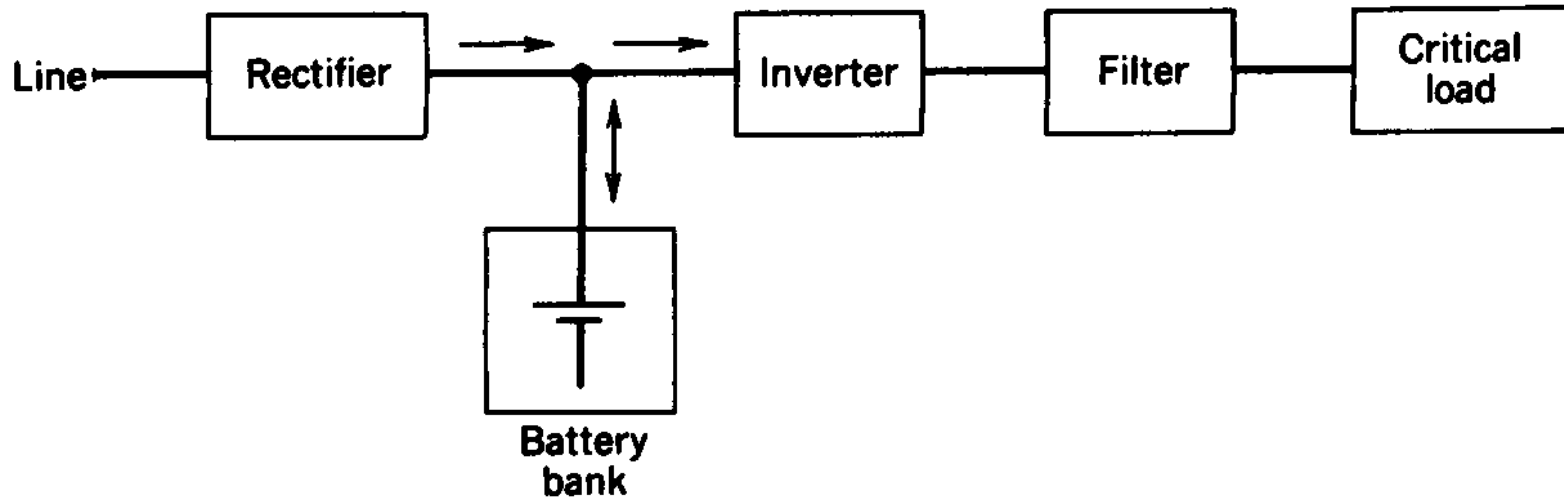


Figure 11-4 A UPS block diagram.

Block diagram; energy storage is shown to be in batteries

UPS: Possible Rectifier Arrangements

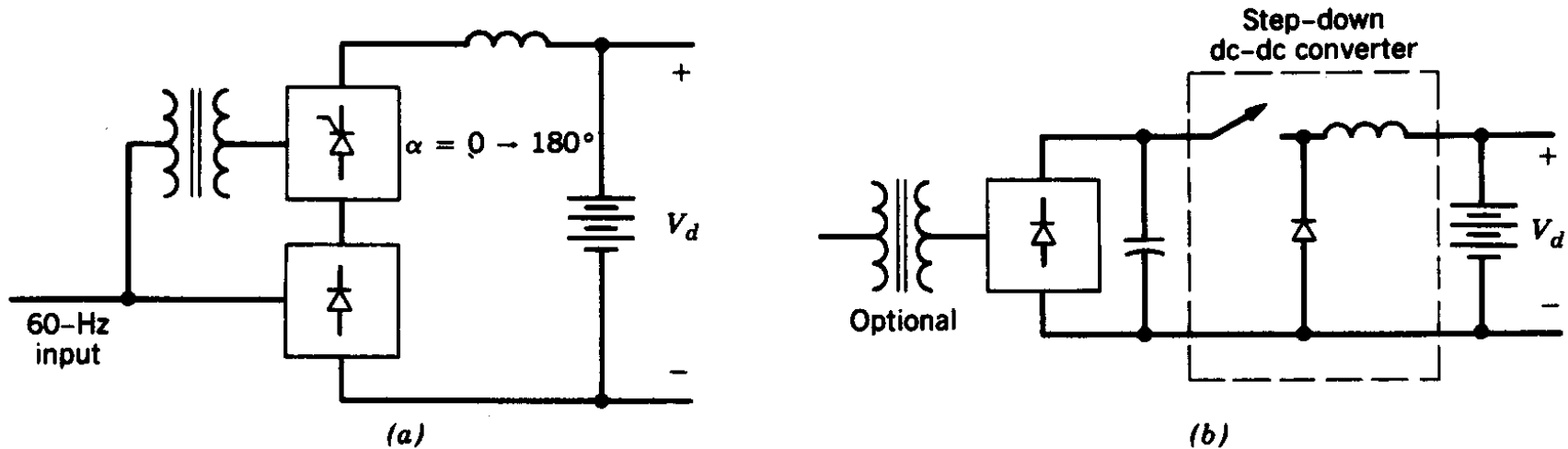


Figure 11-5 Possible rectifier arrangements.

The input normally supplies power to the load as well as charges the battery bank

UPS: Another Possible Rectifier Arrangement

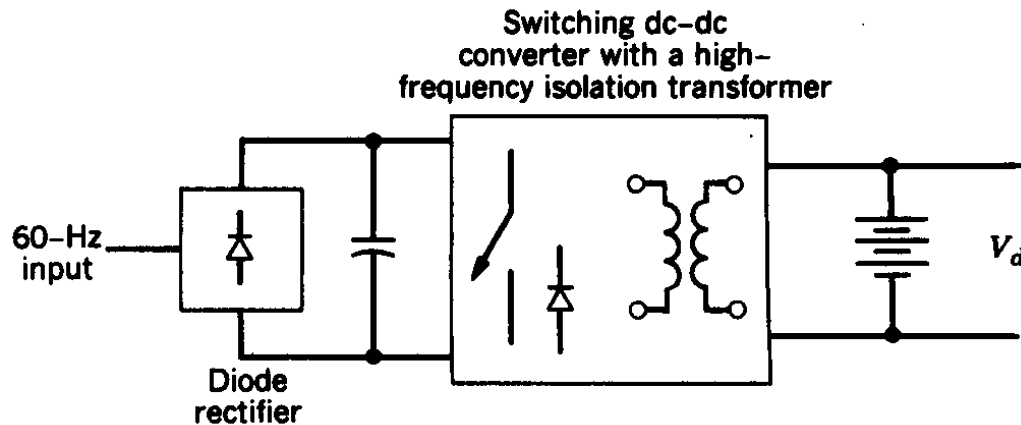


Figure 11-6 Rectifier consisting of a high-frequency isolation transformer.

Consists of a high-frequency isolation transformer

UPS: Another Possible Input Arrangement

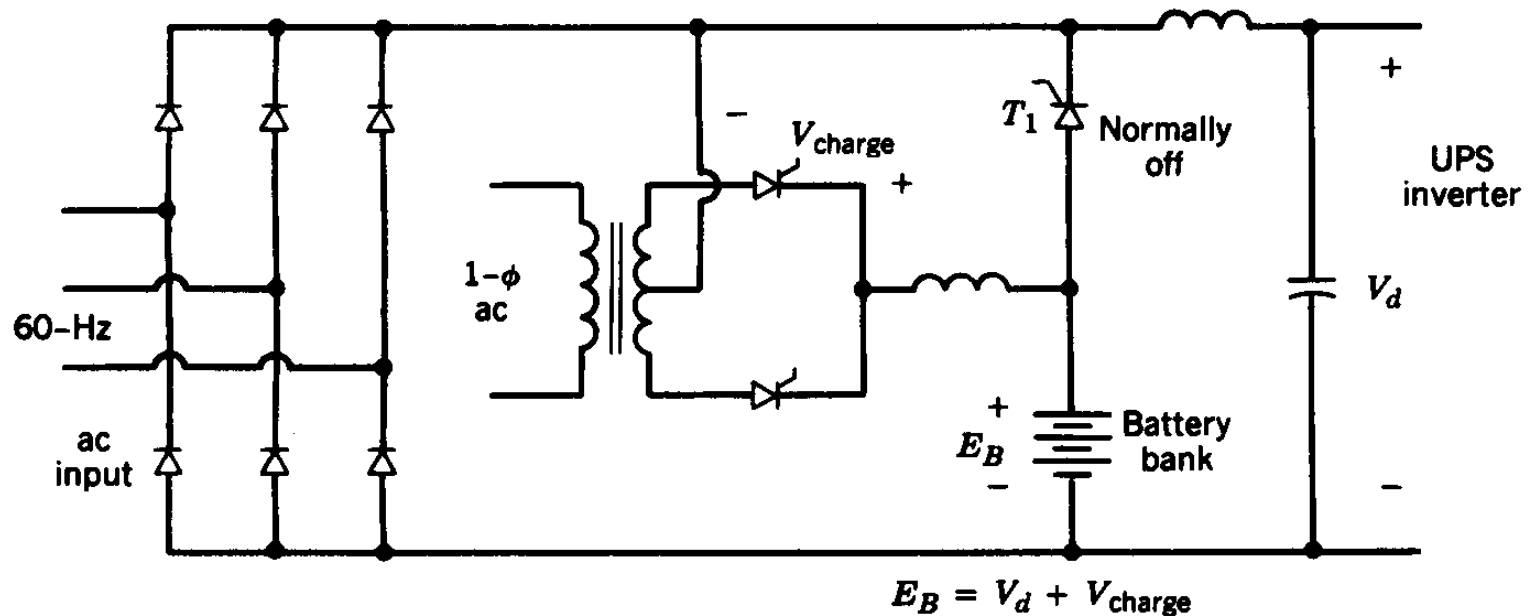


Figure 11-7 A rectifier with a separate battery charger circuit.

A separate small battery charger circuit

Battery Charging Waveforms as Function of Time

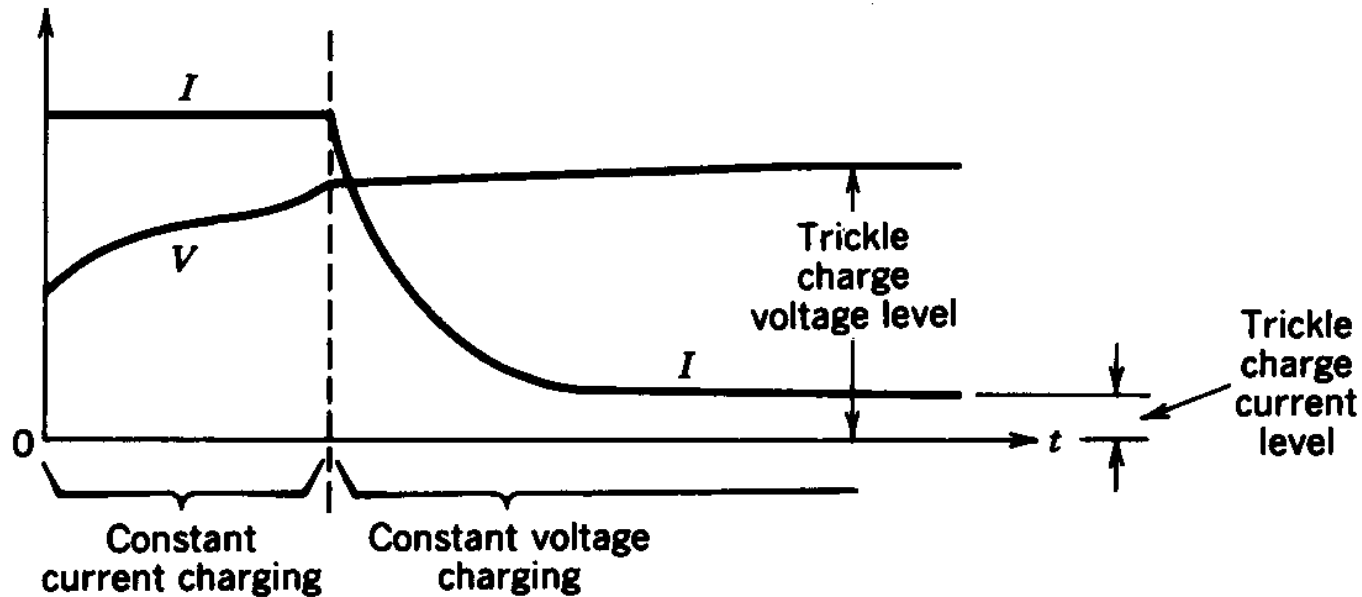


Figure 11-8 Charging of a battery after a line outage causes battery discharge.

Initially, a discharged battery is charged with a constant current

UPS: Various Inverter Arrangements

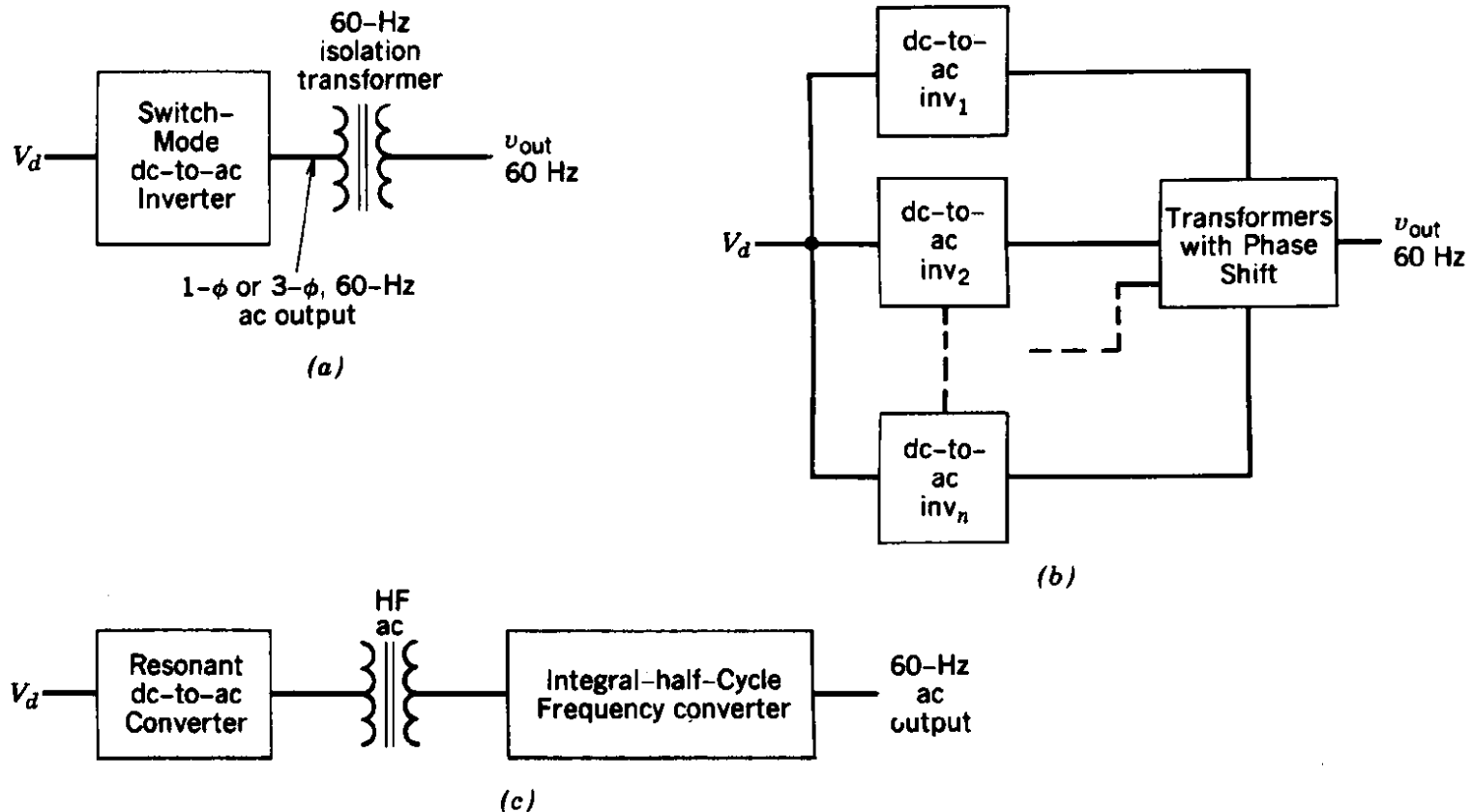


Figure 11-9 Various inverter arrangements.

Depends on applications, power ratings

UPS: Control

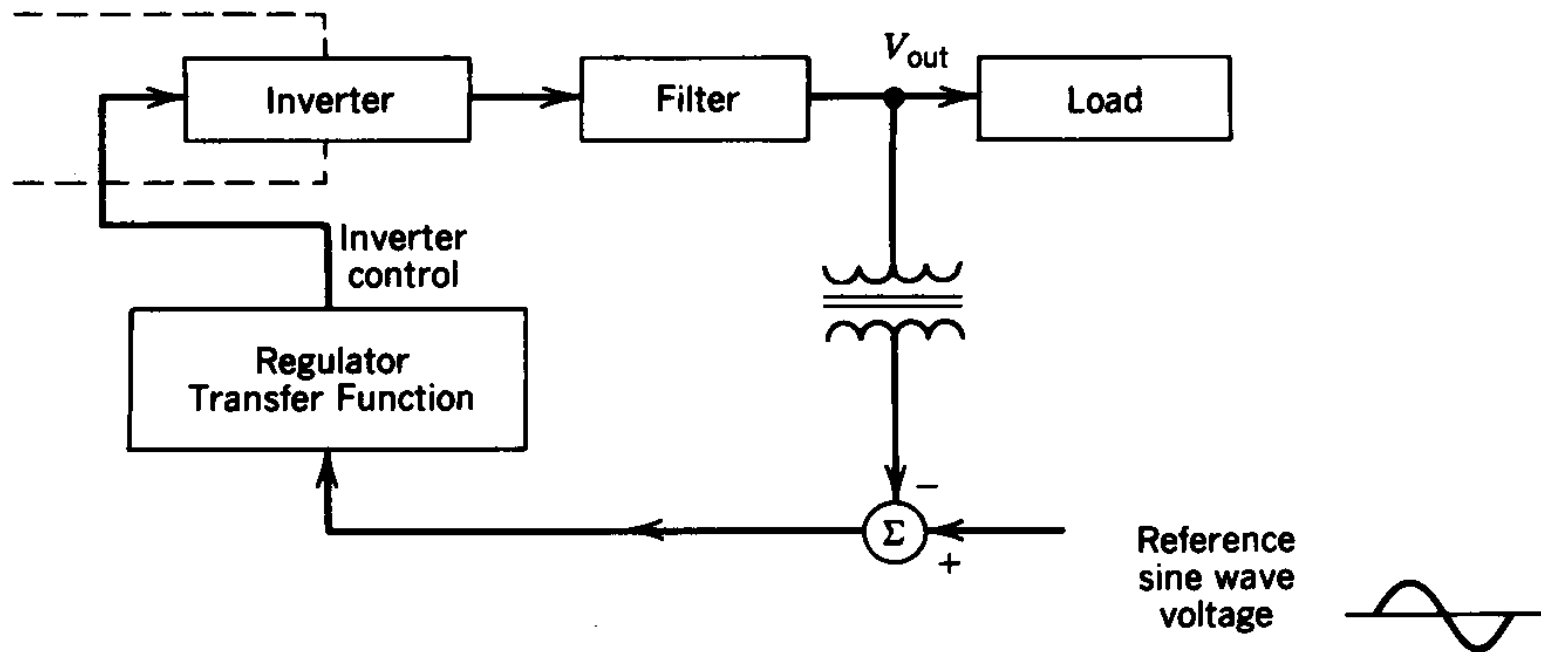


Figure 11-10 Uninterruptible power supply control.

Typically the load is highly nonlinear and the voltage output of the UPS must be as close to the desired sinusoidal reference as possible

UPS Supplying Several Loads

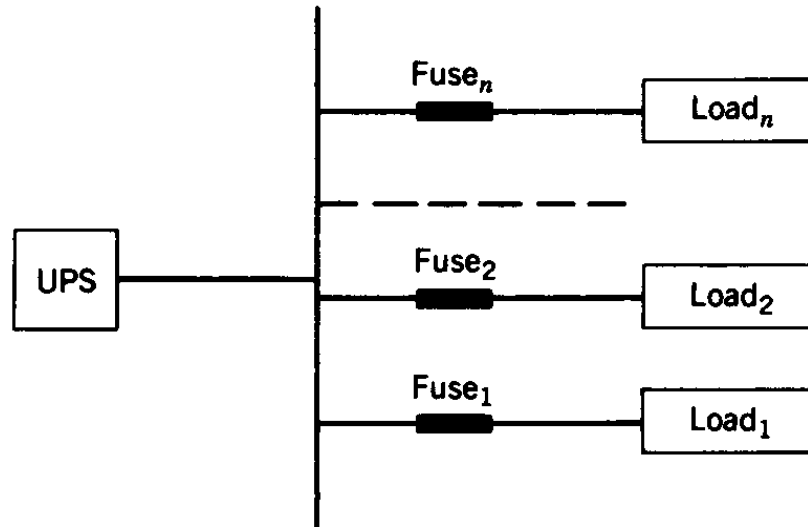


Figure 11-11 A UPS supplying several loads.

With higher power UPS supplying several loads, malfunction within one load should not disturb the other loads

Another Possible UPS Arrangement

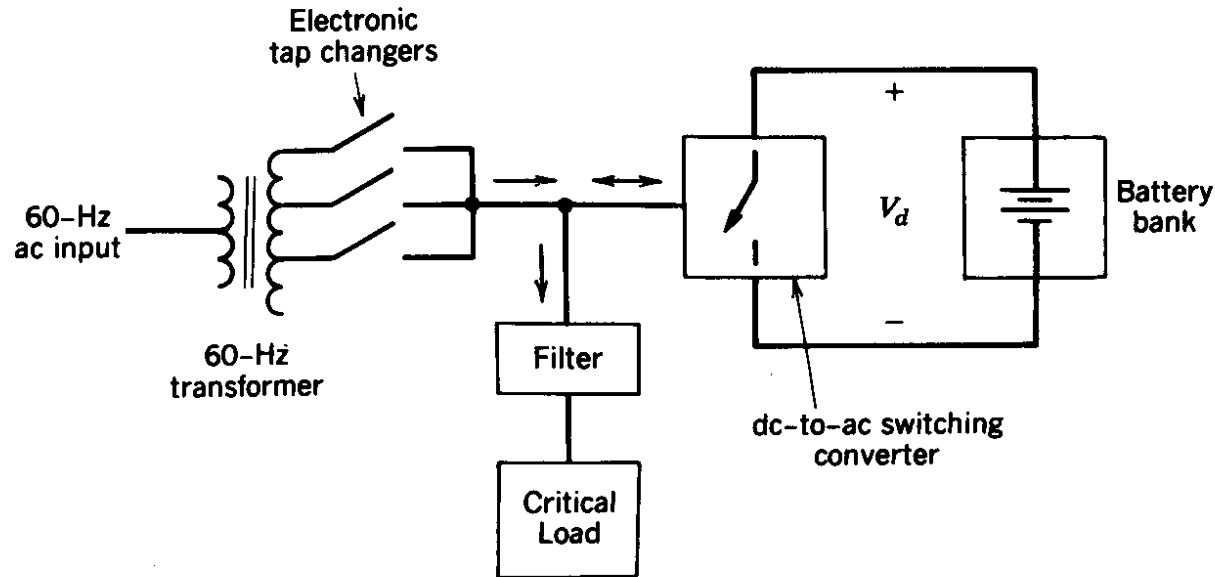


Figure 11-12 A UPS arrangement where the functions of battery charging and inverter are combined.

Functions of battery charging and the inverter are combined

UPS: Using the Line Voltage as Backup

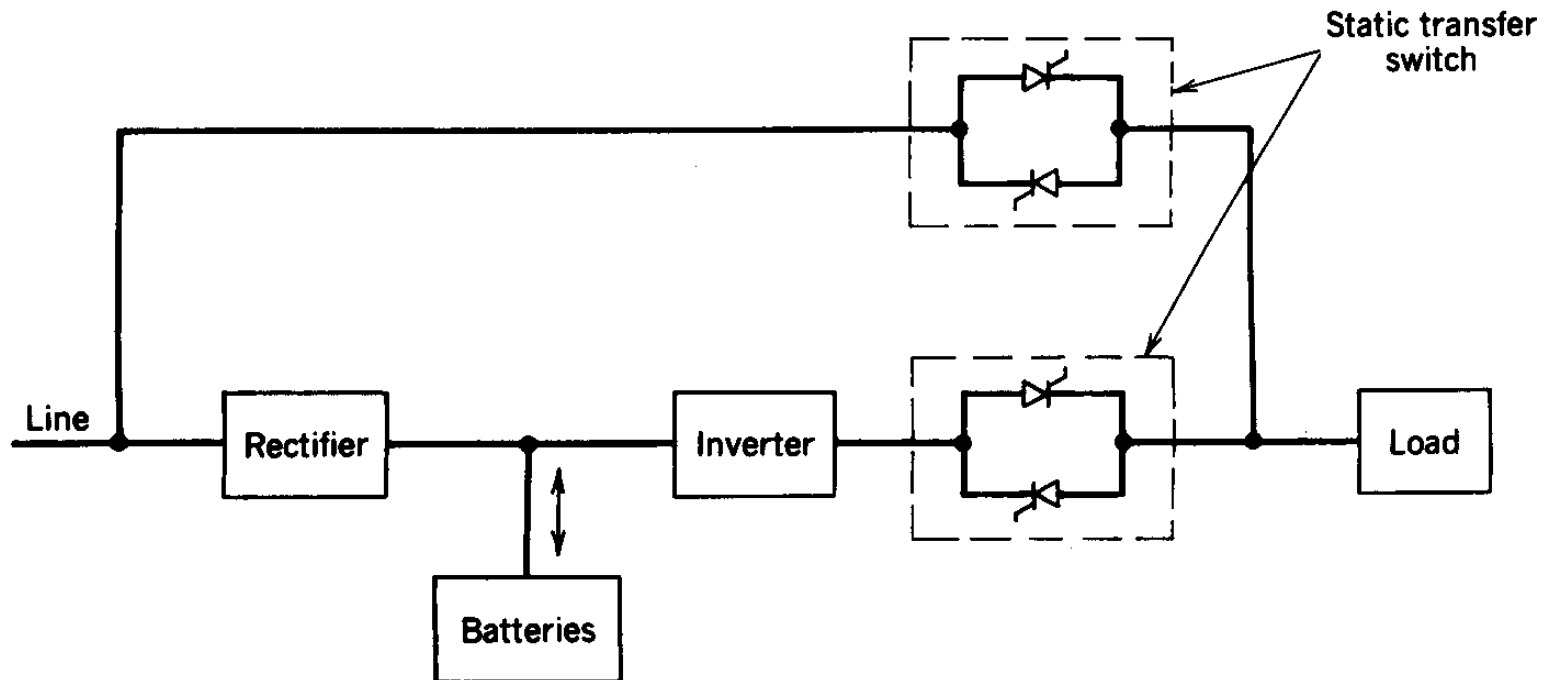


Figure 11-13 Line as backup.

Needs static transfer switches