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Manufacturer of UL Listed Products

TÜV MANAGEMENT SERVICE ISO 9001 TL 9000

TL 9000™
The Telecom Quality Measurement System

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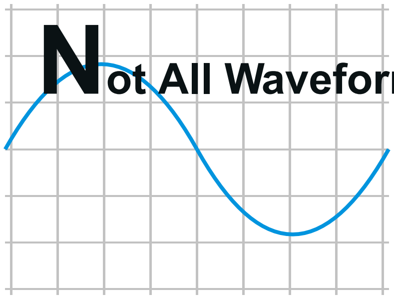


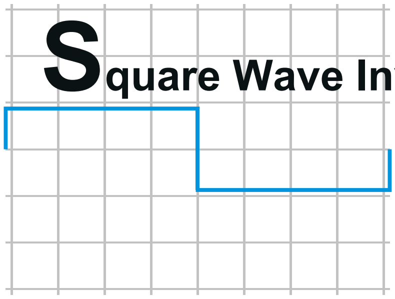
Not All Waveforms are the Same

Inverter technology has advanced far beyond what was available only a decade ago. The first electronic inverters to be introduced were basic square wave inverters. This type has the most limited application and is not recommended for televisions or computers.

As time and technology progressed, a second generation power inverter became popular and was called a "modified square wave" or "quasi-sine wave" inverter. It could be more accurately called a modified-square wave inverter. The "modified-square wave" can regulate RMS (Root Mean Squared) voltage but not peak voltage. This type of inverter will not properly power electronic loads.

Today's technology has produced the most sophisticated power inverters on the market -- true sine wave. Exeltech Inverters deliver the exact output voltage and waveform that exists in home and office environments, guaranteeing that electronic devices will receive a highly regulated sine wave. This inverter provides smooth, continuous power, without noise and voltage spikes which could effect performance or ultimately damage expensive electronic equipment.

Square Wave Inverters



This type of inverter is the simplest and least expensive on the market. Computers, televisions, induction motors, transformer loads and even light bulbs are not recommended to run on this waveform, because the square wave has a high harmonic content. It is not appropriate for operating sound equipment such as stereos, televisions, nor can it efficiently run capacitor start motors, induction motors and transformer loads. While higher quality brands approach 75% efficiency with some loads, typical efficiencies are less than 60%. Standby current drain is in excess of 4 amps, which will drain a car battery in one day even when nothing is plugged into it. In addition, reliability of these inverters is poor. Due to the lack of any protection circuity short of a fuse, certain kinds of overloads and short circuits can seriously damage both the inverter and the equipment.

Output voltage regulation of square wave inverters is poor, usually plus-or-minus a nominal 15 percent. As loads change, outputs can fluctuate as much as 50 volts, from 90 to 140 volts AC. Eventually this will damage sensitive equipment. Another characteristic of this type of inverter is its lack of surge power. This shortcoming is evident when trying to power motorized appliances and tools. Motors are particularly difficult because they can draw three to four times their average power while starting; thus an inverter's lack of surge capability can result in an inability to power motorized equipment.

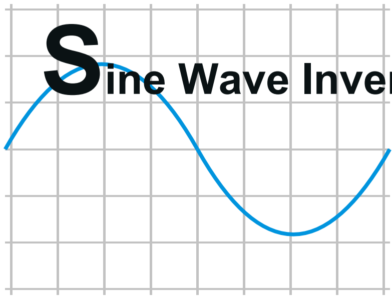
Quasi-Sine Wave Inverters

While quasi-sine wave inverters are an improvement over square wave inverters, they still represent a compromise. They do maintain correct RMS (Root Mean Squared)* voltage for most input voltages, but will only have the correct peak voltage for one input voltage. Quasi-sine wave inverters can be fairly efficient, with some units attaining better than 90%. They may also have high surge power capabilities, and indeed are the correct selection for running some types of motors and incandescent lighting.

The main disadvantage of a quasi-sine wave is that peak voltage output varies with battery voltage. When a vehicle's engine is started, or the load is changed on the battery, peak output voltage changes in direct proportion to input voltage. For example, when the vehicle is not running and battery voltage is approximately 12 volts, output peak voltage would be approximately 140 volts AC. When the car is started, the alternator will drive the battery up to 14.5 volts. This drives peak output voltage of the inverter up to 185 volts AC. In addition, most alternators put out some noise voltage which may be as high as three volts. This will show up on the output of most inverters as 38 volts of noise. Most entertainment equipment cannot filter out this noise. Consequently, this noise is either heard or seen. The output of these inverters will multiply any noise on the input by a factor of about twelve. This shows up vividly on television screens. Expensive electronics should not be exposed to this noise. In fact, operation of some electronic equipment on a square or quasi-sine wave inverter may void the manufacturer's warranty for this equipment.

Many inexpensive electronic devices such as portable televisions, VCRs, and stereos have virtually no internal regulation of their power supplies. They rely on AC line power to have correct peak and RMS voltage to run properly, and are not designed to run on inverter power. As the battery wears down, causing AC voltage to fall, the picture size on most televisions will decrease. Tuners on televisions and radios may drift off frequency causing reduction in volume and an increase in static.

These inverters may appear extremely efficient but this can be misleading. Only 70% to 80% of the energy output from this type of inverter is at 60Hz. The remaining energy is in odd harmonics of 60Hz (180Hz, 300Hz, 420Hz etc. on to infinity). What is important is total system efficiency. If the load cannot use this harmonic energy, it is wasted. This may limit total system efficiency to 60-70%.



Sine Wave Inverters

This is the output from Exeltech Power Inverters and is the correct waveform on which all electronic equipment, televisions, and computers are designed to run. There are different types of sine wave inverters. Most others are of a ferroresonant design which creates a sine wave at the expense of surge power, weight, efficiency and cost. These are mainly used in Uninterruptable Power Supplies (UPS's) in fixed locations. They filter the output voltage well.

Other manufacturers start with a square wave inverter and filter out everything except the fundamental 60Hz sine wave. These units are tremendously inefficient (40% to 60%), and extremely heavy (40 lbs. for a 500 watt unit).

Exeltech Power Inverters are small, light weight, and output a perfect sine wave. This type of inverter can handle instantaneous currents, of nearly three times RMS current rating. They are reliable, incorporating the latest advances in electronic technology. The output waveform is the exact shape on which all electronics were designed to run. No matter what the input voltage, (within the limits of normal operation; 10.5 to 17 Vdc*), output voltage will be 120Vac RMS and 170 Vpeak, the same as utility power.

Output voltage is doubly regulated so it is impossible for noise from a vehicle's electrical system to be transferred to the output waveform. A true sine wave inverter guarantees that all its output energy is at 60Hz. Harmonically sensitive loads such as electric motors will run quietly and efficiently.

Inverter Output Waveforms

A comparison of waveforms is necessary to understand the differences between the various types available.

The following pages contain graphs of three different DC input voltages to three different types of power inverters followed by a discussion of each case.

(A) Represents a vehicle with the engine stopped: Battery voltage at 10.5 Vdc.

(B) Represents a vehicle running under typical conditions: Battery at -13.8 volts with 1 volt alternator whine plus 3 volts of rectification spikes.

(C) Represents a vehicle under running condition with a high output voltage regulator of 16 volts.

To illustrate the effect of each of these conditions with each inverter type, three different loads will be used:

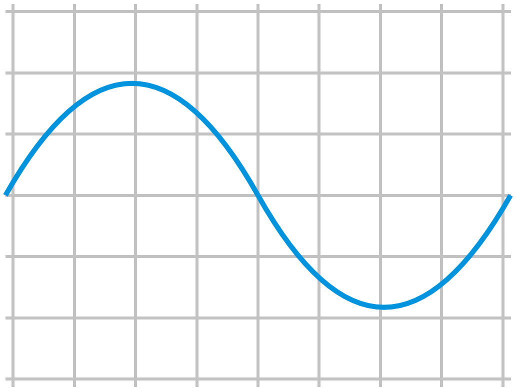
- A simple 100 watt light bulb which is only sensitive to RMS voltage

- A TV set which represents an electronic load sensitive to frequency, peak voltage, RMS voltage, and waveform

- A motor and relay, sensitive to waveform and RMS voltage.

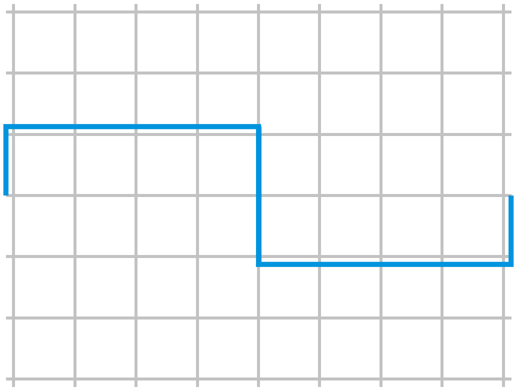
INPUT CONDITIONS
VDC = 10.5V

(A) *Below are waveforms for low voltage at the battery. This condition is indicative of a battery just before it dies.*



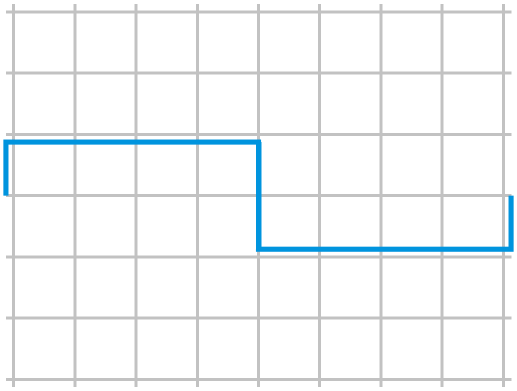
SINE WAVE
Vpk=170 Volts, Vrms=120 Volts

As displayed in the graph, the Exeltech inverter is putting out exactly correct voltages. The TV picture is perfect and the 100 Watt light bulb is still putting out 100 watts. The motor and relay are running cool and quiet.



QUASI-SINE WAVE
Vpk=120 Volts, Vrms=120 Volts

At this point, the quasi-sine wave inverter has degenerated to a square wave output. The 100 watt light bulb will still put out 100 watts and the picture will look fairly good, but it will not totally fill the screen.The relay and motor are running fine, but have an audible buzz and are running hot.

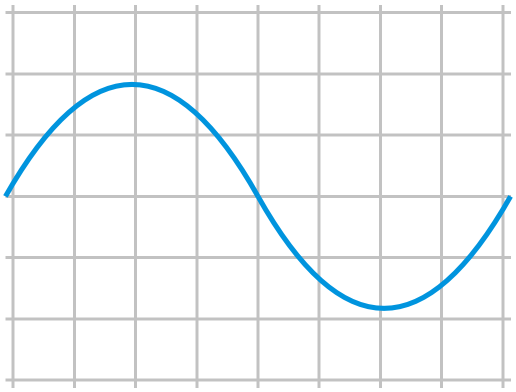


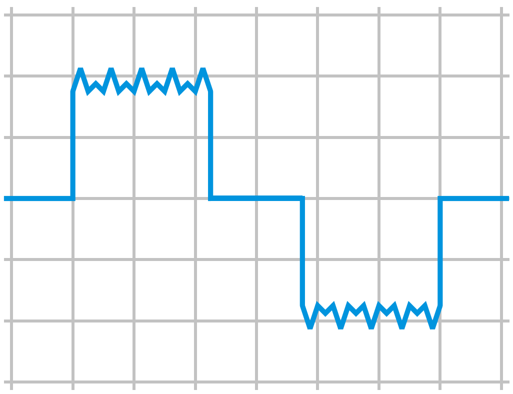
SQUARE WAVE
Vpk=95 Volts, Vrms=95 Volts

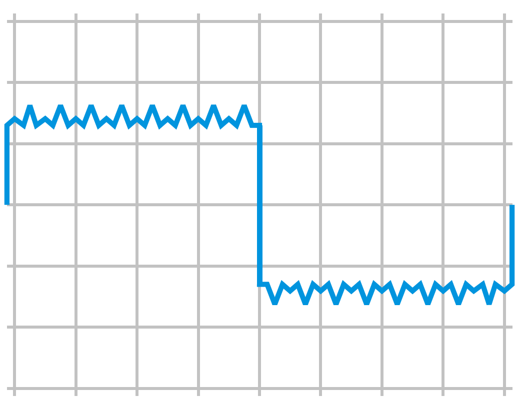
The square wave inverter has a low output voltage at this time, The light bulb is only putting out approximately 67 watts, the TV picture will only fill in ¾ of the screen, the motor may not even start, the relay may not energize, and there will still be an audible buzz.

INPUT CONDITION

V=13.8
3Vp-p= rectifier spikes from alternator
1Vp-p= of alternator whine
.5Vp= random ignition noise







(B) *Below are waveforms operating with a normal battery charger.*

SINE WAVE Vpk=170V, Vrms=120V

The Exeltech inverter is putting out exactly correct voltages. TV picture is perfect, and the 100 watt light bulb is putting out 100 watts. The motor and relay are running cool and quiet.

QUASI-SINE WAVE 40V Noise, Vpk=180V, Vrms=120V

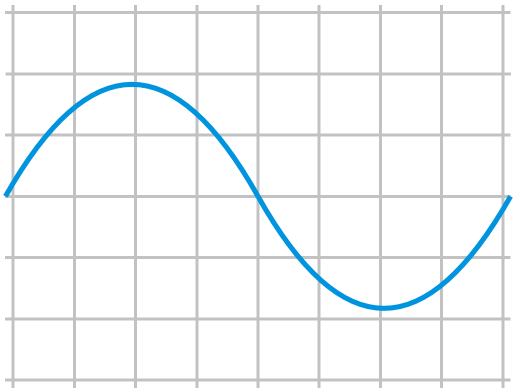
The quasi-sine wave inverter has correct peak voltage and correct RMS voltage. The light bulb output is correct. The TV picture appears correct but the power supply is being bombarded by 200V current spikes occurring at a 120HZ rate. There may be audio and video noise in the TV due to the harmonics of 60HZ. These frequencies fall into hearing range and can pass through TV circuits to the speaker. The motor and relay will have proper RMS power but will be running hotter and will be buzzing due to high harmonic energy.

SQUARE WAVE 30V Noise, Vpk=125V, Vrms=125V

The square wave inverter is powering the bulb to near nominal levels. Since peak voltage is not high enough, all the power supplies in the TV are too low, dropping out of regulation. This allows all noise and harmonic energy of the waveform to pass into the audio and video circuits. The best of these inverters are only 1% frequency controlled, which may lead to hum bars rolling through the screen and herring-bone patterns in the video. The motor and relay have adequate power and are running hot and buzzing.

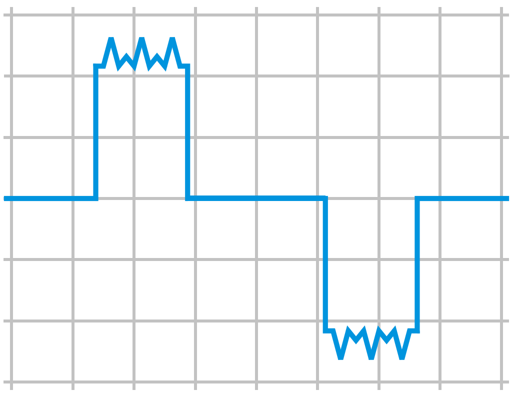
INPUT CONDITION
VDC= 16 volts
3Vp-p rectifier spikes from alternator
1Vp-p of alternator whine
.5Vp random ignition noise

(C) *Below are outputs indicative of a running vehicle, battery fully charged. This is typical of many vehicles and charging systems with poor regulation.*



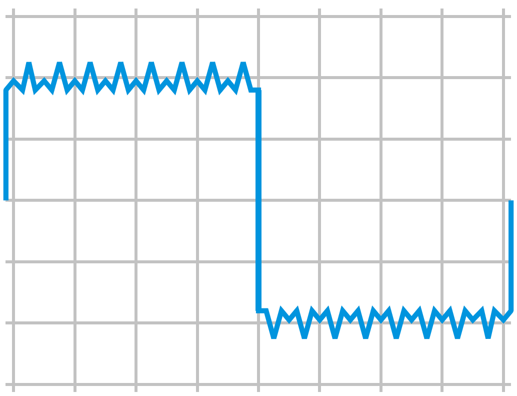
SINE WAVE
Vpk=170V, Vrms=120V

Exeltech inverters put out exactly correct voltages. The TV picture is perfect, the 100 watt light bulb is putting out 100 watts, and the motor and relay are running cool and quietly.



QUASI-SINE WAVE
40V Noise, Vpk=220V,Vrms=120V

Now peak voltage is too high but RMS voltage is correct. The light bulb output is correct. The TV is receiving peak voltage that is too high, therefore the screen may be "ballooned". The supplies are being bombarded by 220V pulses at a 120 HZ rate. All harmonic energies are still there and potentially getting into audio circuits. The motor and relay are running but getting hot and are buzzing.



SQUARE WAVE
30V Noise, Vpk=145V, Vrms=145V

The square wave inverter is over powering the light bulb, which will result in reduced life. Peak voltage to the TV is still low, as are the low voltage supplies. All the noise arguments from the previous pages are still valid. The motor and relay are now extremely hot and are buzzing.

Only the Facts

There is another vintage of modified square wave inverters which can be identified by their light weight (approximately 100 watts per pound). These inverters are an improvement over other modified square wave inverters, but they have other problems. They are less expensive to produce than square wave inverters but are usually more expensive. The output peak voltage is never correct -- only 145 volts. This is done to minimize harmonic energy and improve efficiency. These inverters have incorrect waveforms, incorrect peak voltage and a high harmonic energy that destroys audio. Line and load regulation on these units is typically poor, which means they will not supply their rated power when running on batteries alone.

Exeltech power inverters properly power any type of load efficiently and effectively. Its stable, regulated sine wave output provides unequalled performance when compared to any other inverter of its size on the market.

Exeltech power inverters are truly the "wave" of the future.