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GERMAN SECURITY SOLUTIONS

Jammer
Principle of Operation

GOVERNMENTAL SECURITY SOLUTIONS

Jammer – Principle of Operation

Generally, there are the following kinds of jammer known:

- Spot jammer
- Sweep jammer
- Barrage jammer
- Sequential jammer (broad)
- Band jammer
- Pulse jammer

All of them are useful in a special application. For our purpose, spot-, barrage-, sequential and pulse Jammers are not sufficient because they will always leave gaps in frequency or timing for a typical signal which is used by remote controlled explosive activator.
So basically, the decision has to be made between sweep and broad band Jammers. We are handling both modes of operation since many years, so a lot of experience and know how is with the company.
The advantage of broad band Jammers is that a very wide frequency spectrum can be covered at the same time without any timing-gaps. This kind of system, however, will provide a very little power output per frequency channel. The result is a very bad coverage of distance from the place of operation. The best way to use such a jammer is relatively close to the endangered place, only in this case it will work sufficient. For the mobile use, e.g. in convoys, a longer distance has to be covered for security reasons.

Here we will never know where the explosive receiver is actually located.

For this reason the sweep jammer is in any case the best solution.

Comparison between a broad band (white noise) jammer and the 3260S double digital sweep jammer:
Broad band noise jammers often have the following characteristics:
Broadband signal: 300 Watt, 10 to 550 MHz

This means: The power to be measured is present in this total band at the same time! Mostly the power measurements are done by a thermal wattmeter or something similar. These equipments "collect" the power within their frequency bandrange. If we look now to the power spectrum in a little bit more detailed, we can state: 300 Watts are distributed over a bandwidth of 540 MHz (550 MHz – 10 MHz). A broadband, or noise signal is present at every frequency, this is the physical characteristic of "noise".

Following this, we can see that the given 300 watts total power is spread over the band the same time (which looks very good for the first view). If we ask, however, how many watts are devoted to 1 MHz in this band, for example between 20 to 21 MHz things change dramatically: 300 W/ 540 MHz = 0,55 Watt per Megahertz! Or even worse, for 100 KHz: 300 W/(5400*100KHz) = 0,055 Watt per 100 KHz
All other calculations are irrelevant; you will never have more peak power! If, as other technical data tries to insist, there would be 300 watts at each moment at each frequency, we can trust calculate simply for the same 1 MHz bandwidth: 300 Watt/MHz *540 MHz = 162,000 Watt = 162 KW This is, as everyone can understand, simply not possible.

As an additional difficulty, often these Jammers have just one output, so only one antenna can be connected for the whole band! The wavelength, to be covered by this antenna, is between 30 meters (10 MHz) to 54 centimetres (550 MHz). Everyone who has a certain knowledge about antennas will clearly realize that there is no antenna available on today's world market that could cover this total range without producing immense losses! So, in the end, there will be not as much useful signal as indicated in the datasheets.

Effective Jammers, like the 3260S work with a different mode, the so called sweep mode. A real radio signal is produced first, which can be calculated by measurement exactly, for example a 10 watts peak carrier. This signal will show with a wattmeter and also with a spectrum analyzer, its 10 watts and can be handled according to the requirements of a proper RF design. (with a noise signal this is almost impossible, because noise is a random phenomenon.)

The second step with this kind of jammer is to find or design an antenna that can really work in a certain band, to this allowed band the Jammers band has to be adjusted. For example, if the antenna is able to cover the band from 30 to 100 MHz it is not logical to make the Jammers frequency band greater than this. Therefore, the 3260S modulated carrier will be moved with high speed just between the 30 to 100 MHz and will always have a real existing power input of 10 Watt. The output power varies with the power stage amplifiers used for a specific frequency range (HF &V/UHF power stage amps are running at 150 and 100 Watt!)

This means: More than at least 180 times the resulting power than with a noise jammer! The speed is high enough to the single frequency to interrupt the coding of the signal in a remote radio controlled explosive system.

Summary

If we compare a 10 watts noise jammer to a 10 watts sweep jammer, both will show the same output power to a power meter. The effective power is, however, actually very different between these two systems:

A. The noise jammer produces a maximum peak power of + 20 dBm and most of signal is below that, around + 10 dBm. In other words, the power to be transmitted is between 10 mW and a maximum of 100 mW but never 10 watts!

B. The sweep jammer really produces a 10 watts peak level signal. This can be measured by a power meter and spectrum analyzer! This real signal is moving fast over the band to be covered, and provided the RF design is properly done, it will also have its value over the entire band.

So, using the 120 watts (in the basic 3250 model) of output power, the system provides real 10 watts at the antenna – a broadband noise jammer typical 10 to 100 mW!

Double digital sweep principle – is it fast enough for our scenario?

The technology within the 3250 / 3260S systems based upon a double digital sweep principle, which transmit each frequency separately within a very fast time period (interval) of around 1 millisecond! Therefore each single frequency within the Jammers range is transmitted every millisecond giving total spectrum coverage at any time period. Using this advanced method of frequency transmission, the PSD (power spectral density) at any point in the Jammers frequency range is very high as each centre frequency is receiving. The full output of the amplifier unlike with a noise barrage system, where the output from the amplifier disturb evenly across the frequency range, resulting in a very low PSD and hence a limited protection zone.

In a practical scenario, the first and the last cars in a VIP convoy are equipped with 3260S Jammers each equipped with directional antennas, covering an ahead distance of approx. 300 meters. (please refer to following graphic) This convoy is driving at a speed of 200km/h, which means:

200 km/h equal to 55.55 meter/sec (55.55 m/sec = 0.055 m/msec, equal to sweep rate)

Sweep rate = 1 msec: in 1 millisecond the convoy moves 5.55 centimetres! (driving speed 200 km/h)
As you can see, the protection for the VIP is at high end, there's no point to worry, the sweep jammer will destroy each frequency of the target, quick enough, even driving at higher speeds than 200 km/h – the bomb will explode far away from you, always approx. 300 meter ahead-
Like bullet proofed vests, armoured cars, or even simple things like safety belts, airbags, ABS and side impact protection for almost every driver of today's modern cars, the 3260S offer additional safety and high security that often go unrecognized.

Reports available on frequencies used by criminals?
Analysis reports are available by Interpol. There were attacks at 27 MHz, 287 MHz, 40 MHz, 80 MHz, 120 MHz and 430 MHz and also one famous one in the cellular phone band (GSM900). Anyhow, terrorist prefer equipment which they can buy without showing any ID card, etc., typical equipment is: electronic from remote controlled toys, amateur handheld radios (2m/70 cm) available in electronic shops, etc.

When does a jammer explore bombs on his own?
The above question often arises when talking about Jammers. There is not a simple answer that could describe a certain output power of a certain distance from the bomb's receiver that a jammer must be to cause a bomb to explore. Things are a little bit more detailed in this matter.
Some basic technical details:
A jammer has an output power of 10 watts. A normal radio remote control equipment is used for this calculation. Transmitter 100 mW output power, receiver sensitivity 5uVolts/m.distance TX<->RX = 100 m, frequency 70 MHz. First we convert all dimensions to dBm to have easier calculation:

10 watts = +40 dBm
5 uV = - 93 dBm
100 mW = + 20 dBm

Free space attenuation for 100 meters = 49.34 dB

The first very important value is the receiver's sensitivity of -93dBm. This means, that a very small signal is enough for reaction of the receiver. At the antenna input, the receivers signal should be at least 0.5 picowatt -93 dBm.

The transmitter:
It transmits 100 mW, or + 20 dBm, and this power is attenuated roughly 50 dB over a distance of 100 meter. So +20 dB = -30 dBm at the receiver. That means 63 dB more than the receiver. That means 63 dB more than the receiver needs as a minimum for operation (to detonate). In the given case, the transmitter and the receiver are always ''connected'' by a radio signal; the transmitter is always ON, when the receiver is ON, too. This is a normal mode of working with every remote control to be bought. The transmitter holds the receivers output stage, to prevent undefined reaction.

Typical VIP convoy with sweep jammer:
Escort car 1 and 2 are equipped with 3260S Jammer, effective directional protection area 300 meters ahead. For a powerful counter measure, the following conditions have to be considered:

1. Jammer power at the place of bomb receiver has to be stronger than a transmitter power of 2 watts in a distance of 100 meters.
2. The remote frequency is unknown and the jammer signal has to present on all known bands.
3. The response time of a remote control can be very short (down to 3 msec), so there will be no time to receive and analyze a terrorists transmitter signal and to switch a selective jammer to his frequency.

3260S: Sweep rate = 1 millisecond
Convoy driving at a speed of 200 km/h is
Moving only 5.55 centimetres per millisecond!!!

Please note
We will recognize, however, the different reactions of the explosive radio receivers: Some are coded in a way that they will not react when disturbed by the jammers signal. They simply 'close' their decoding. Others will go down in sensitivity of their first stage of receiver amplifier. Both effects come out the same: the receiver will simply not be able to work anymore, so the terrorist cannot ignite his bomb.

Different from these operating modes is another one which allows the system to be easily interfered. These will start to 'flicker' as soon as another signal is present. In this case, we don't exactly know the receivers reaction. It is possible that one of these 'flicker-pulses' is enough to ignite the bomb, this is not a malfunction of the jammer, it is normal for this kind of receiver.
This will occur, however, far away from the jammer source, so that a car equipped with a 3260S will ignite the bomb itself, early and far away enough that the blast will not hit it's real goal.
As an additional difficult, often these kinds of Jammers have just one output, so just one antenna can be connected for the whole band!
The wavelength, to be covered by this antenna, is between 30 meters (10 MHz) and 54 centimetres (550MHz).
Everyone, who has a certain knowledge about antennas, will clearly realize that there is no one antenna available on today's world market that could cover this total range without producing immense losses!

So, in the end, there will not be as much useful signal, as indicated by the paper.
Effective Jammers, like the HP 3260, work through another mode: A real radio signal is produced first; which can be calculated and measured exactly, for example a 10 watts peak carrier. This signal will show with a wattmeter, and also with a spectrum analyzer, it's 10 watts and can be handled according to the needs of a proper RF design. (With a noise – signal, this is almost impossible, because noise is random phenomenon.) The second step with this kind of Jammer is to find or design an antenna that can really work in a certain band. To this allowed band, the jammer band has to be adjusted.

For example, if the antenna is able to cover the band from 30 to 100 MHz, it makes no sense at all to make the jammers band greater than this. Therefore, the HP 3260's modulated carrier will be moved with a high speed just between also the 30 and 100 MHz, and will always have a real existing power of 10 watts when crossing the single frequency.
(That means, more than at least 180 times the resulting power than with a noise – jammer!)

The speed is high enough to return to the single frequency to interrupt the coding of a signal in a remote system, (adjustable between 0.1 t 1 msec for the whole band).

A Jammer can interfere now in different ways:

1. The jamming signal becomes, as the jammer gets closer to the receiver, bigger than the original TX signal and simply "overwrites" the original signal. Now the receiver can react just by a chance; its output will start to flicker, and the contact relais or something similar will blow of the bomb. This, however start as soon as the jammer signal has the same strength at the receivers antenna input, as the original transmitters signal.

   In our example this means, the 10 watts (+40 dBm) jammer signal also has to be attenuated to around -30 dBm, and this will occur at a distance of approx. 300 meters from the receiver (free space attenuation 70 MHz on 340 meters is exactly 59,97 dB.

   From this point on, we don't know exactly how the receiver will react 300 meters are, however, enough to make an advanced explosion without serious damage to jammer car and the VIP behind.

2. With better receives, the reaction is different. We can refer to some figures as before, but the receiver will have an automatic gain control (AGC) for received field strength. This means, if it receives a stronger signal, the sensitivity goes down, prevent distortion in the coding signal. If it is equipment like this, and the jammer is coming closer, so that again both signal will have the same value at receives antenna, the automatic gain control will now start to close the receiver's sensitivity down. The effect is that the original TX cannot get to the receiver any more, no reaction to the bomb – blowing signal will not take place.

   So summing up the receivers reaction, both modes of operation will give safety to the jammer protected car. With the first case, an explosion will take place before the convoy is close enough to be destroyed by the bomb, in the second case an explosion will be suppressed.

The sweep jammer family – short overview

3250		*3260S (high power)*	
HF	20 to 80 MHz	10 Watt	150 Watt
VHF	80 to 200 MHz	10 Watt	125 Watt
UHF	200 to 500 MHz	10 Watt	100 Watt
SHF1	500 to 1000 MHz	10 Watt	
SHF2	1000 to 2400 MHz	10 Watt	

Antennas	
HF	complex arrangement of 4 monopoles
VHF	binomial antenna, monopole
UHF	logarithmic periodic dipole (same for SHF1 band)
SHF2	broad band patch antenna

COMPARISION between a white noise jammer and HP 3250/60 system

Basically:
Noise jammers often have the following characteristics:
Broadband signal, 300 watts, 10 to 550 MHz.

This means, the power to be measured is present in this total band at the same time. Mostly the power to be measurements is done by a thermal wattmeter or something similar. This equipment are "collect" the power in their band-range.

If we look now at the power spectrum in a little bit more detailed, we can state:
300 watts are distributed over a bandwidth of 540 MHz. (550 – 10)
A broadband, or noise, signal is present every time every frequency; this is the physical characteristic of "noise".

Following this, we can state that the given 300 watts total power is spread over the ban between 10 to 550 MHz the same time,(which looks very good at the first view). If we ask, however, how many watts are devoted to 1 MHz in this band, for example, between 20 to 21 MHz, things change dramatically.

We have to divide the total power by the number of MHz, in this case:

300 / 540 = 0,55 per MHz !

Or, even worse, for 100 KHz

300 / 5400 = 0,055 watts per 100 KHz

If you would like further Information about ELAMAN,
or would like to discuss a specific requirement or project, please contact us at:

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