Maintenance of retail theft prevention systems with a Fluke ScopeMeter®

Application Note

Worldwide almost one million installed theft prevention systems need to be maintained on location to check interference. This application note describes the procedure for on-site maintenance with a Fluke ScopeMeter. It also discusses the best ScopeMeter for this application and probe selection.

Theft prevention systems

Theft prevention today consists of Close Circuit TV and Tag-and-Alarm systems, also known as Electronic Article Surveillance (EAS) systems. Almost one million EAS systems have been installed worldwide, primarily in retail shops. The EAS tag or label is attached to the merchandise. The shop assistant will remove or deactivate the tag when the merchandise is bought. When a thief carries it through the gates, the alarm will sound.

The majority of EAS systems use RF sweep signals with a frequency of 7.4 to 8.8 MHz to cover different label frequencies. If a tag attached to a product passes the gates, it responds to its specific frequency emitted by a transmitter antenna, and the response from the label is picked up by the receiver antenna, which triggers the alarm.

Figure 1: *8.2 MHz tags.*

Figure 2: *EAS swept RF system.*

Tuning procedure of an RF swept system

Checking transmitter output and frequency

Your oscilloscope must have a 10:1 probe (see section Probe Selection below). With the oscilloscope probe, create a loop around the crossbar of the transmitter pedestal with the ground lead connected to the mini alligator cable, and connect the mini alligator clip to the probe tip. You should get a display like the one shown in Figure 3. If you get a display like Figure 4, trim the transmitter board until you arrive at a display like Figure 3.

The wave amplitudes should be to be as high and as flat as possible, and the frequency of each wave should be high.

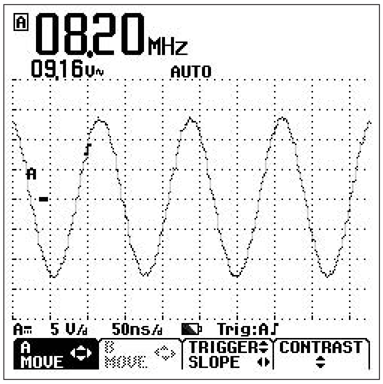

Figure 3:

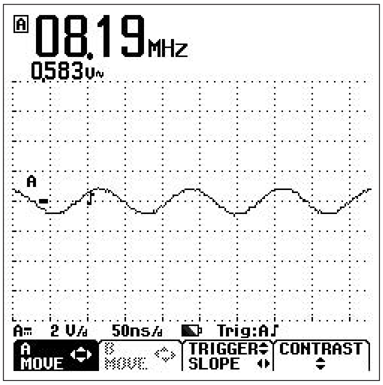

Figure 4:

Screen captures from a Fluke ScopeMeter 123 with 10:1 probe VPS40.

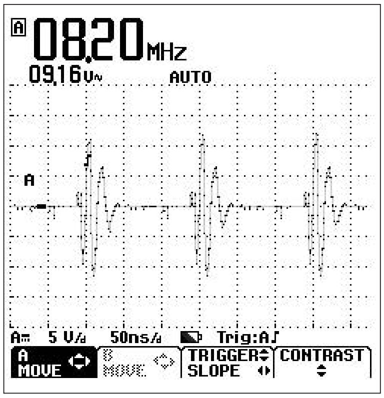

Figure 5: Label wave crests.

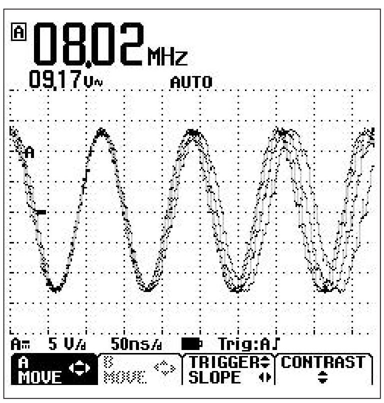

Figure 6: Fluke ScopeMeter 123 with VPS40. 10:1 probe

Label check

Hold a label between the system pedestals close to the bottom. Because this will trigger the alarm, you might want to disconnect the beeper temporarily. You should see sets of 3 wave crests at equal intervals like those shown in Figure 5.

Note: This procedure is for oscilloscopes without autoranging. The pictures in Figures 3 and 4 are taken with a Fluke ScopeMeter 123. If you want to see the low amplitude signal from Figure 4, you have to set the ScopeMeter 123 in Manual mode, otherwise it will range automatically for optimal signal display and you will have to watch the Vac amplitude reading.

Swept frequency check

If the sweep frequency deviates, adjust the sweep on the sweep potentiometer of the transmitter board until you arrive at the display given in Figure 6. On the screen you see the frequency reading changing quickly from 7.4 up to 8.8 MHz with the waveform fixed at the trigger point and varying at the right part of the screen. This tells you that it is sweeping, but not the upper and lower sweep frequencies exactly.

With the Fluke ScopeMeter 199C in the Envelope Mode you can place cursors for reading time or frequency.

If you select reading 1/T you can read the upper and lower swept frequency directly in MHz.

ScopeMeter® selection

ScopeMeter 123 or 124

The black and white screen captures shown above are taken from a Fluke ScopeMeter 123 and VPS40 10:1 probe. Besides allowing you to see waveforms and measure swept frequencies, the ScopeMeter 123 can be used as a digital multimeter to measure frequency, voltage, resistance, diodes and connectivity with the probe STL120 included with the instrument. Using the optional VPS40 10:1 voltage probe, you can measure up to 20 MHz with a ScopeMeter 123 and up to 40 MHz with a ScopeMeter 124.

ScopeMeter 199C

The colored screen captures shown above are taken from a ScopeMeter 199C. This 200 MHz portable scope, featuring a 2-channel color screen, is capable of all the measurements referred to above. In addition, with the instruments Envelope Mode with cursor reading it is possible to read the upper and lower swept frequencies directly in MHz. With the ScopeMeter 199C, you can use the VPS200 200 MHz 10:1 probes supplied as standard with the instrument, or the optional very low input capacitance VPS201 100:1 probe.

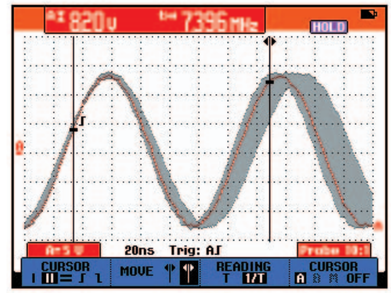

Figure 7: Cursors placed at maximum period, lowest frequency. See actual waveform in red.

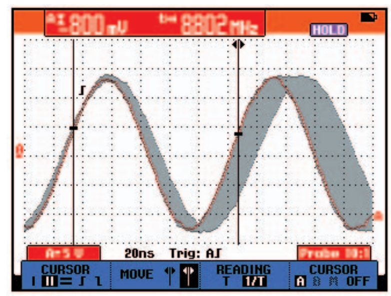

Figure 8: Cursors at minimum period, highest frequency.

Probe selection

The above tuning procedure used a 10:1 scope probe but doesn't explain why this probe is needed. An item people tend to forget is the source loading of the probe, especially the source loading at higher frequencies. Since these theft prevention systems produce frequencies from 2 to 10 MHz, it is important that the transmitter output is not loaded with a large-capacitance probe (like the standard STL120 test leads supplied with ScopeMeter 123) since this will pull down the RF output.

A test point can be thought of as a signal source. Any external device, such as a probe, that's attached to the test point can appear as an additional load on the signal source behind the test point. This loading, or signal current draw changes the operation of the circuitry behind the test point, and thus changes the signal seen at the test point. An ideal probe causes zero signal source loading. In other words, it doesn't draw any signal current from the signal source. This means that, for zero current draw, the probe must have infinite impedance. In practice, it is not possible to have a probe

with zero signal source loading since a probe must draw some small amount of signal current in order to develop a signal voltage at the ScopeMeter input. Consequently, some signal source loading is to be expected when using a probe.
The goal, however, should always be to minimize the amount of loading through appropriate probe selection.

Resistive source loading

The resistive loading effect can be neglected in this application. 10:1 probes typically have a resistance of 10 MΩ and 100:1 probes typically have a resistance even higher. For most cases, these values result in virtually zero resistive loading.

Capacitive source loading

Usually, the loading of greatest concern is that caused by the capacitance Cin at the probe tip.

For low frequencies, this capacitance has a reactance that is very high, giving little or no effect. But, as frequency increases, the capacitive reactance decreases. The result is increased loading at high frequencies. Capacitive loading can be minimized by selecting probes with low tip capacitance values.

A lower capacitance can be obtained by selecting a probe with a higher attenuation factor.

The table gives some typical capacitance values and attenuation factors for various probes.

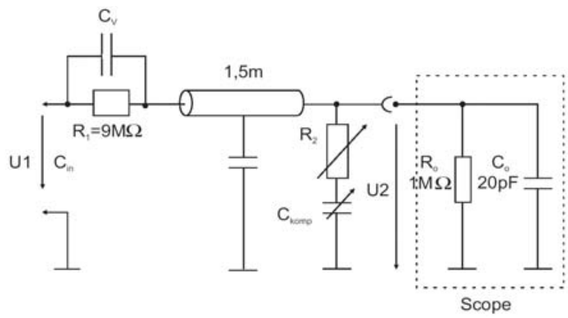

Figure 9: *Typical circuit of a 10:1 Scope Probe.*

Reactance

Reactance is the impedance element that reacts to an AC signal by its current flow based on the signal's frequency.

The input capacitor C_{in} presents a capacitive reactance to AC signals that is expressed in Ω by the following relationship:

$$X_C = \frac{1}{2\pi f C}$$

where:
X_C = capacitive reactance in Ω
f = frequency in Hz
C = capacitance in F

Reactance versus Frequency

	VPS 201	VPS 200	VPS40	STL 120
C_{in}	6.5 pF	14 pF	14 pF	225 pF
1 kHz	24 MΩ	11 MΩ	11 M Ω	0.7M Ω
1 MHz	24 kΩ	11 kΩ	11 kΩ	707 Ω
10 MHz	2.4 kΩ	1.1 kΩ	1.1 kΩ	71 Ω
100 MHz	245 Ω	114 Ω	114 Ω	NA
200 MHz	122 Ω	57 Ω	57 Ω	NA

This table shows that you load the RF transmitter with 1.1 kΩ at 10 MHz.

Probe model	VPS 201	VPS 200	VPS40	STL 120
ScopeMeter 190 Series	❍	●	NA	NA
ScopeMeter 123/124	❍	❍	❍ / ●	● / ●
Attenuation	100:1	10:1	10:1	1:1
Resistance (at probe tip)	100 MΩ	10 MΩ	5 MΩ	1 MΩ
Capacitance C_{in} (at probe tip)	6.5 pF	14 pF	14 pF	225 pF

❍ Optional ● Included

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