

## Microwave measurements for the loose-end detection at cigarettes in a packing machine

### **1. Introduction**

When packing cigarettes into packages, a detection of cigarettes with a loose end, that means faulty cigarettes with a lack of tobacco at the tobacco end of the cigarette, should be implemented. Common sensor systems for the loose-end detection are optical sensors and mechanical sensors. The signal of the optical sensors depends on the colour of the tobacco, and these sensors are unable to detect several typical damages of the cigarettes (e.g. a 'cone end'). The mechanical sensors have to be positioned precisely to work properly. This demand for precise positioning leads to a limitation of the speed of the packing machine.

For these reasons the common sensors shall be replaced by sensors, that do not show these disadvantages. The company TEWS ELEKTRONIK has developed special microwave sensors for the loose end detection. This application has been published, e.g. as EP 1739411 B1. Test measurements had been carried out to prove the suitability of the sensors for this task.

### **2. Realisation of the tests**

To test the microwave sensors, a cigarette package conveyer was used, and a microwave sensor was applied from the side at the tobacco end of the cigarettes. Though three sensors for three rows of cigarettes were at hand, the experiments were carried out by use of one single resonator, that was connected to a microwave electronics MW3010 (TEWS Elektronik). The sensor was set to the bottom layer of cigarettes. The signals were recorded by use of a storage oscilloscope. As measuring objects ordinary king size cigarettes and Kretek cigarettes were used.

The mass-proportional microwave signal was compensated in respect of a varying moisture content of the cigarettes. Furthermore, a standard moisture calibration for cigarettes had been written to the microwave electronics. Thus the delivered signals of the microwave measuring device were on one hand the moisture of the tobacco end of the cigarette and on

the other hand a mass-proportional signal, that is not influenced by a varying moisture content of the tobacco.

### 3. Measurements

Figure 1 shows the mass signal of seven cigarettes (ordinary king size cigarettes) as a screenshot of the a storage oscilloscope. An ordinary package of king size cigarettes contains seven cigarettes in the first layer. In the figure, the positions of the single cigarettes are marked by the seven left red bars, the eighth bar on the right marks the end of the package. The profile is warped on the left hand side, because the conveyer is not moved uniformly, but stepwise, and the velocity of the cigarettes increases during one measuring period. So the signal of the cigarette in the first position (left hand side) results mainly from the product at rest.

Figure 2 shows the mass signal of the same cigarettes with a substitution of the cigarette in the 6<sup>th</sup> position by a cigarette with a cone end. A cone end is a loose end, where the tobacco is still present in the middle of the cigarette, but is missing in the outer regions. While a defect like this is hard to detect by optical sensors, the microwave signal shows a significant decrease at the position of the faulty cigarette.

Another defect, that can not be detected by an optical sensor, is the absence of tobacco at the end of the cigarette, when the top is still covered by a tobacco leaf. To simulate this defect, one cigarette was prepared by substituting the tobacco by wool and covering the top of the cigarette with a thin layer of tobacco. The result of the microwave measurement can be seen in Figure 3: The prepared cigarette can be detected easily as faulty by use of the microwave signal.

Figure 4 shows a measurement at Kretek cigarettes. Faulty cigarettes again can be detected easily. A pollution of the sensor by sugar stemming from this kind of tobacco, that can blind the top of an optical sensor, has no influence on the microwave measurement. The influence of a possible crust on the sensor can be eliminated by measuring the empty state of the microwave sensor periodically. The periodical measurement of the empty state of the resonator can be performed automatically in each gap between the single cigarette packages.

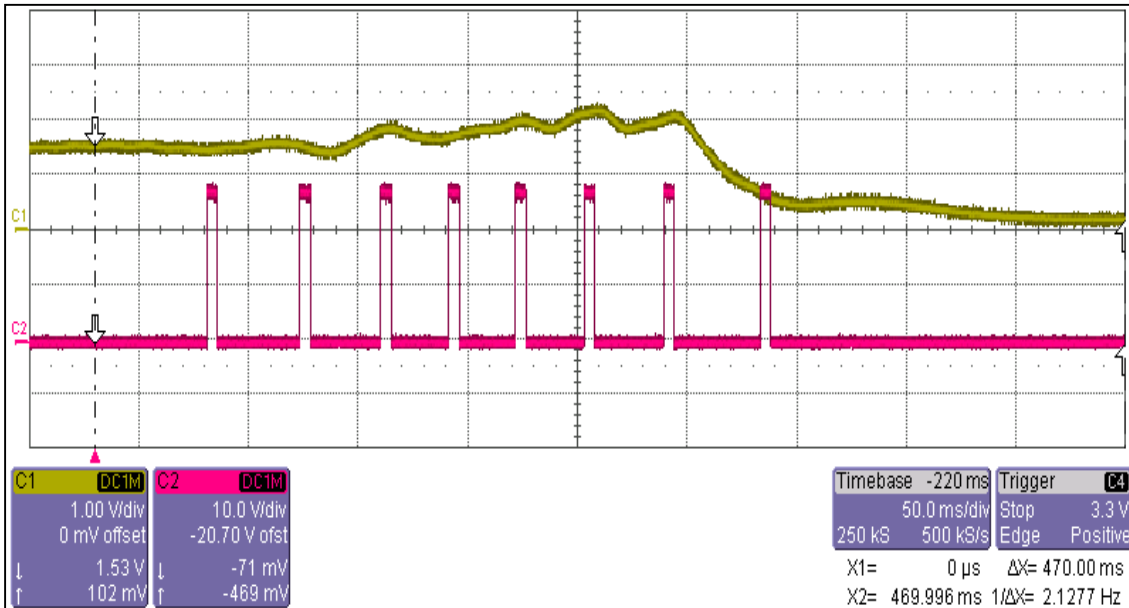


Figure 1: Signal of seven cigarettes with full tobacco content

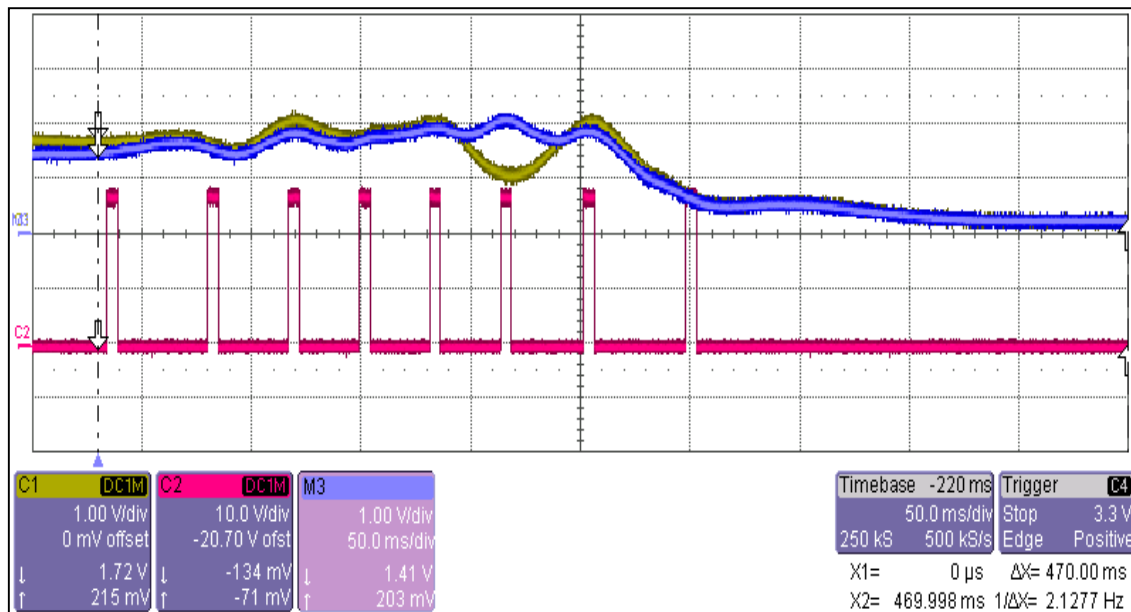


Figure 2: 6<sup>th</sup> position: cigarette with cone end

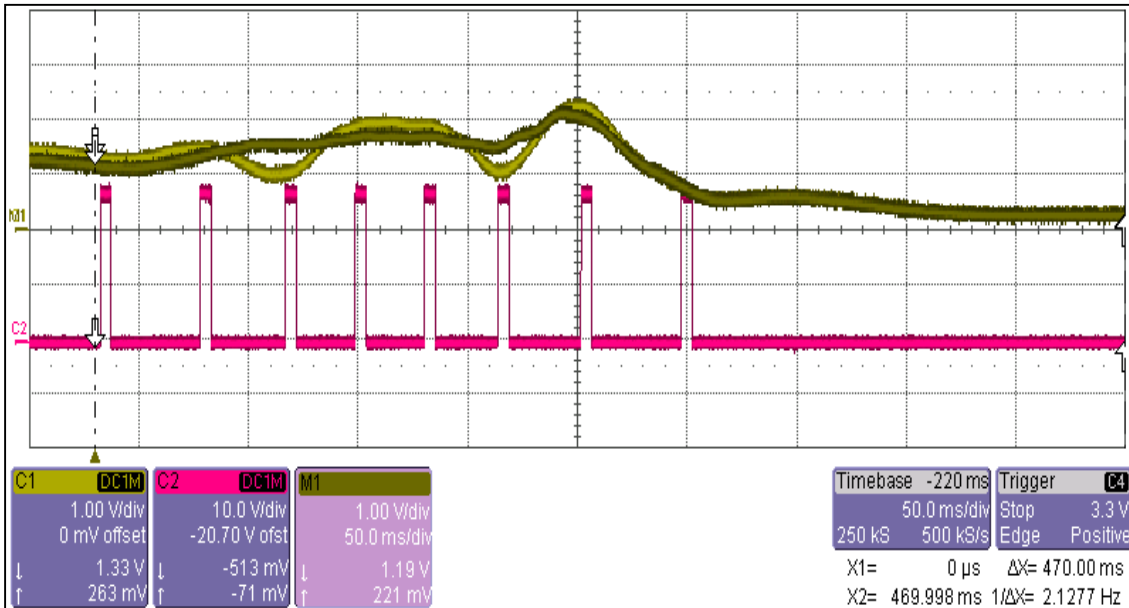


Figure 3: 3<sup>rd</sup> position: cigarette filled with cotton and slightly covered with tobacco 6<sup>th</sup> position: cigarette with cone end

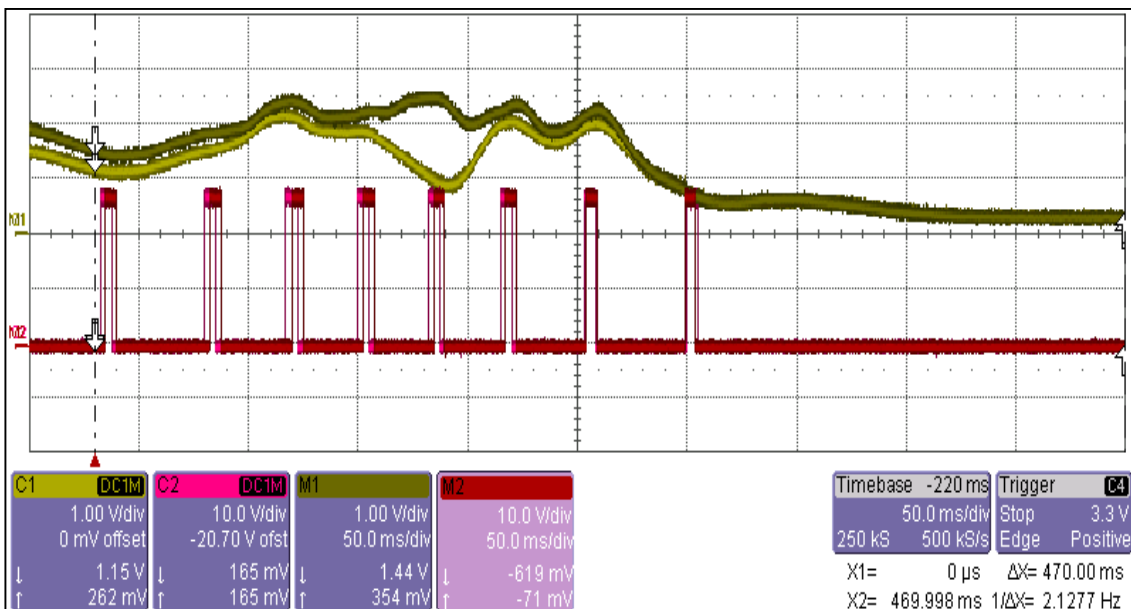


Figure 4: Kretek tobacco, 5<sup>th</sup> position: cigarette with loose end

#### 4. Influence of the distance between sensor and cigarette

The distance between microwave sensor and cigarette has got an influence on the mass signal. So the cigarettes are 'zeroed' by pushing them against a guiding wall just before they pass the microwave sensor. The position of the cigarettes varies with a rotation of the conveyer, because of a variation of the guidance of the cigarettes on the conveyer. Figure 5 shows the signals of three measurements. The zeroing was only carried out before the first measurement. So a clear difference can be seen between the measured profile with zeroing and those without zeroing.

Figure 6 shows three profiles measured at the same cigarettes with zeroing before each measurement. The profiles are nearly identical. Thus a zeroing is important for the quality of the microwave measurement. Many packing machines are already equipped with pushers for an automatic zeroing near the measuring position, because the signals of optical sensors also depend on the distance between sensor and cigarette.

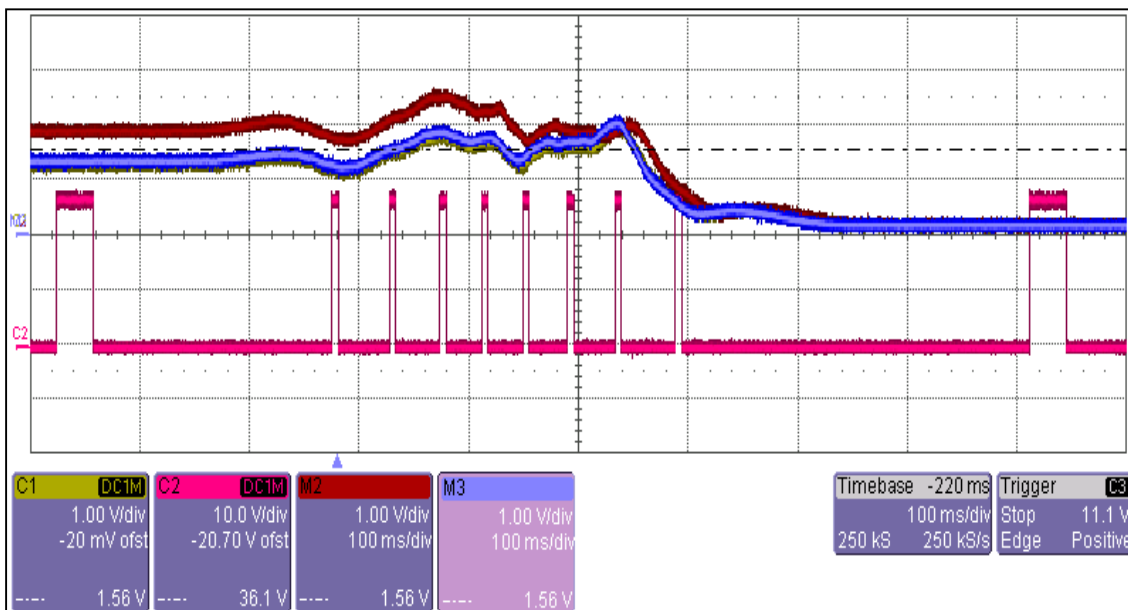


Figure 5: Zeroing of the cigarettes only before the first measurement

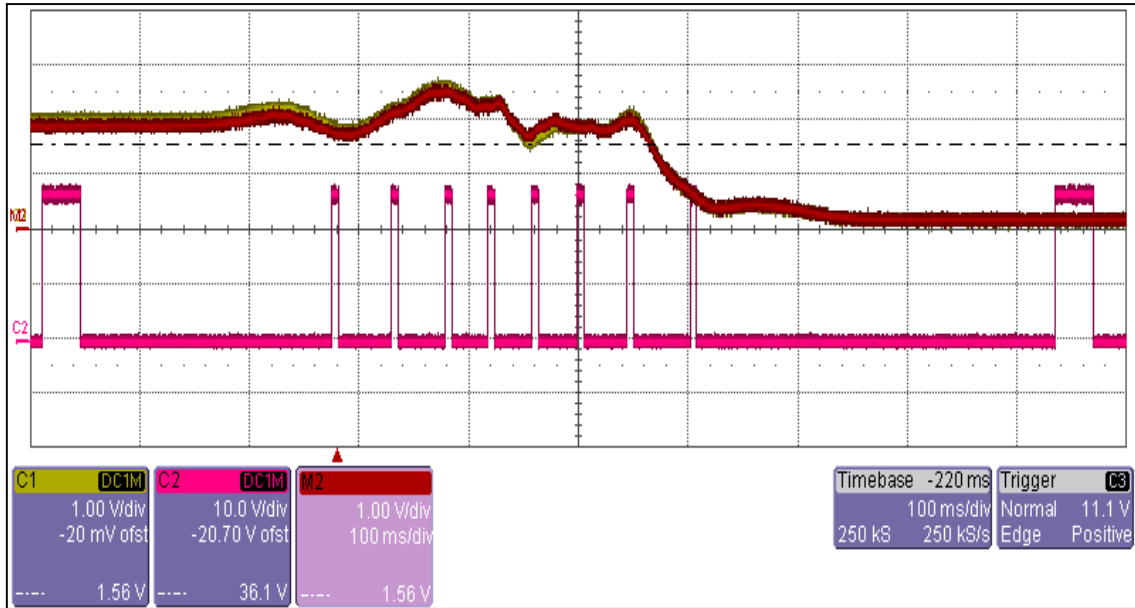


Figure 6: Zeroing of the cigarettes before each measurement

## 5. Conclusions

- The company TEWS Elektronik has developed microwave sensors for the loose-end detection at cigarettes. This application has been published, e.g. as EP 1739411 B1.
- The microwave sensors are small enough to replace e.g. an optical sensor system without changing the cigarette packing machine significantly.
- The microwave measuring technique is well suitable for the loose end detection at cigarettes. The moisture content of the cigarettes is measured at the same time.
- The microwave signals are independent of the colour of the tobacco.
- Typical damages of the cigarettes, e.g. cone end, loose end covered by a tobacco leaf, that can not be detected by an optical sensor, can be detected easily with a microwave sensor.
- The microwave sensor is well suitable for the loose end detection at Kretek cigarettes. A pollution of the sensor by sugar stemming from this kind of tobacco, that can blind the top of an optical sensor, has no influence on the measurement.
- The microwave measurement is very fast, and thus there is no limitation of the speed of the packing machine.
- The distance between microwave sensor and cigarette has got an influence on the mass signal. So it is important to 'zero' the cigarettes by pushing them against a guiding wall just before they pass the microwave sensor. Many packing machines are already equipped with pushers for an automatic zeroing near the measuring position.

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