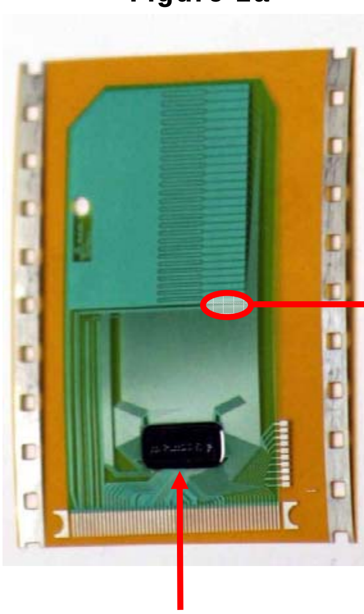
# High Frequency Co-Planar Amplitude Modulated RF Fingerprint Sensing

Validity has significantly improved the superior imaging characteristics of deep finger penetrating RF based sensing technology by utilizing a completely new plate structure and transmitter/receiver configuration. This new topology, which operates at much higher frequencies than previously used, enables significant advances in performance, reliability, and cost. Operating the sensor at greater than ten times the frequency of existing RF sensor technology produces a higher quality, deeper penetrating image. Reliability is greatly enhanced because the new topology allows Validity to mechanically decouple the sensing elements from the silicon drive chip, overcoming the mechanical fragility and ESD susceptibility problems associated with direct contact silicon (commonly known as “tap and zap” failures). Moving the sensing elements off the silicon die also allows Validity to reduce sensor costs over time by following a traditional die-shrink product roadmap, unlike direct contact sensors, which cannot be shrunk to less than the width of an industry standard fingerprint.

The Validity Fingerprint Sensor is fabricated by etching sensing plates directly onto an independent substrate made of Kapton® film (figure 1), to which the silicon die is attached using a standard Chip-on-Flex (COF) process. The fragile die is located away from the sensing area that is contacted by the user’s finger. Typically, the die is covered by the case of the device housing the sensor. Reliability is further enhanced by having the etched plate elements and driver chip on the reverse side of the film which the sensor plates easily image through. The result is a sensor that can withstand +/-16KV of ESD without any special chip top coatings that can wear off or protective ground rings than can cause annoying leakage currents into the human body. Due to the inherent durability of the Kapton® film, the sensor can withstand high amounts of abrasion and a pen drop test over 2 meters and still enroll and match fingerprints well. It is also much easier to seal the electrical interconnect from exposure to moisture or other potential corrosion since all circuitry resides on the opposite side of the barrier film which is also resistant to commonly used cleaning chemicals.

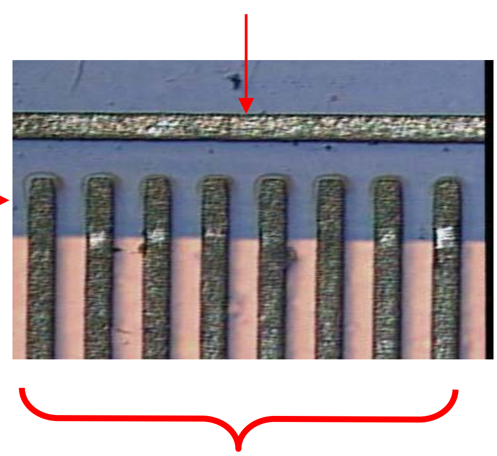
**Figure 1a**



Driver Chip

**Figure 1b**

Pickup



Drive Plates

**VFS101 on Flexible Film**



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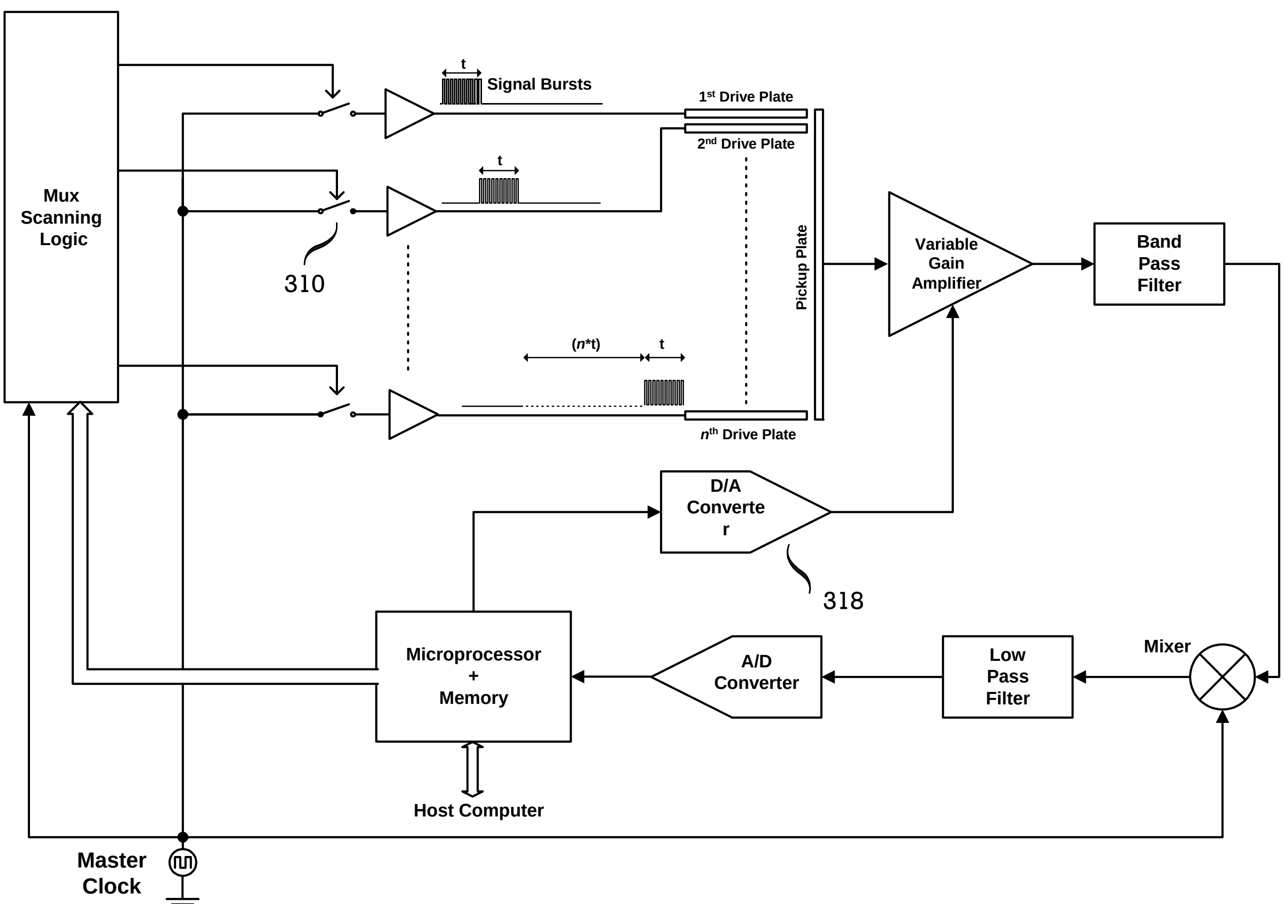
The basic plate architecture shown in figure 1, consists of a fine line comb structure etched from industry standard metalized Kapton® film. The 8 parallel drive plates shown in the exploded view are part a bank of 250 drive elements driven by the remotely located chip. At the heart of the technology is a patented pulsed RF technology that effectively creates more than 250 AM transmitter/receiver pairs by multiplexing many low cost transmitters with one precision receiver as is illustrated in figure 2 below. (This is opposite to the approach of competitive fingerprint sensors which employ a single large drive ring and a large array of small phase detecting receivers.) Since there is only one receiver for the entire imager, that receiver can be made very high quality and has a much better dynamic range than an array of thousands of receivers can.

Each of these drive lines are activated in a linear sequence, and the signal received at the pickup plate is sampled at the exact time a corresponding line is activated.  The magnitude of signal at the pickup plate is directly related to the RF impedance of a finger ridge or valley placed near the gap between the drive lines and pickup plate. Validity's high frequency RF method deeply penetrates the finger surface, giving excellent wet dry finger performance. Complete fingerprint images are created by scanning successive lines of the finger as it is swiped over the gap, much like a two dimensional fax image is captured by line-by-line scanning.

**Figure 2**



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## Companion Position Sensor and Motion Correction Software:

In order to reconstruct a two dimensional image from individual line scans, one needs to know the speed at which the finger was scanned across the sensor. In practice this speed can vary significantly during the scan. To solve this problem Validity has integrated a companion finger position sensor just above the image sensor as shown in figure 1a. The position sensor consists of a series of horizontal plates which are etched on to the same low cost film substrate. This sensor is built using the same RF sensing technology and uses the same driver chip to collect a real time rate/position profile of a finger during a scan. That data is then used to construct a motion corrected 2D image of a finger. The pictures below demonstrate the effectiveness of the motion correction process.

It is important to note that the combination of information from the two sensors in the Validity VFS101 product provides a new level of anti-spoofing protection that allows a Validity sensor to pass difficult tests such as the gummi-bear false finger test popularized by Tsutomu Matsumoto

**Before Correction**

**After Correction**