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Acoustic surface wave image scanner

K. Asakawa and I. Uchida

Central Research Laboratories,
Nippon Electric Co., Ltd.
Kawasaki, Kanagawa

1 Introduction

Acoustic surface waves can be applied to optical processors by means of a hybrid combination with semiconducting photosensors.[1)2)] A new type of high speed acoustic surface wave image scanner with tapped electrodes connected to a Si-photodiode array is proposed. Reading of optical characters with 7 bits and bit rate of 6MHz is demonstrated.

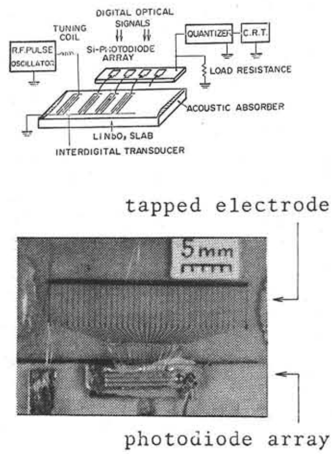


Fig.1 Experimental configuration and photograph of electrodes and photodiode array.

2 Experimental result

This device is based on electromechanical conversion efficiency of the interdigital transducer being varied by the change of the load conductance, i.e. by the change of the intensity of incident light on the photodiodes.

Experimental configuration is shown in Fig.1. Thirty three interdigital electrodes are arranged on the Y-cut plane of a $LiNbO_3$ slab, one for a generator and the others for detectors, the latter of which are bonded to the diode array. Figure 2 shows an experimental measurement of output load current versus intensity of incident light on the diodes. Figure 3(a) is an example of output sequential signals when the image was focused on the middle 7 diodes of the array shown above. Upper traces are load current and lower traces are binary signals corresponding to optical patterns. Figure 3(b) shows a display of optical characters read by this one dimensional scanner. Bit rate and repetition time of the surface waves are 200ns and 10μs, respectively. It suggests that this device presents no less speed OCR utilization than that of a CRT.

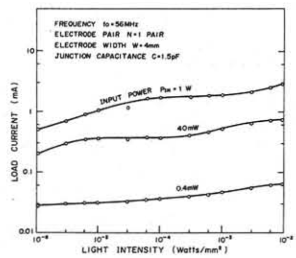
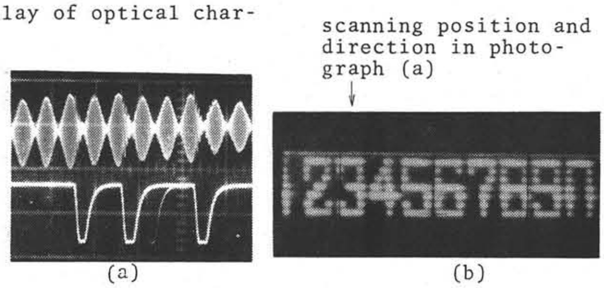


Fig.2 Experimental measurement.



(a) (b)

Fig.3 (a) Output sequential signals. (b) C.R.T. display of optical characters scanned by surface wave devices.

An equivalent circuit of a

tapped transducer and a photodiode can be described as in Fig.4, because an electrode is considered as a displacement current source due to piezoelectric polarization. An analysis of scattering parameters of a tapped electrode[3] presents acoustic power ratio P_{21} of the transmitted power, and P_{31} of the tapped to the incident power into one electrode. The latter results in the calculation of load current versus conductance G of a diode, shown in Fig.5. The value of G being proportional to light intensity, the curves of Fig.5 are fitted to the experimental result in Fig.2. Since acoustic waves are attenuated due to tapping energy into the load, maximum bit number N_{max} is limited by a transmission efficiency P_{21} and load current ratio η of illuminated state to dark state. Relations of η, N_{max} and P_{21} are computed in Figs.6(a) and (b), when $G = 10^{-3}\mho$, for example. This allows simultaneous utilization of a grouping of several hundred electrodes.

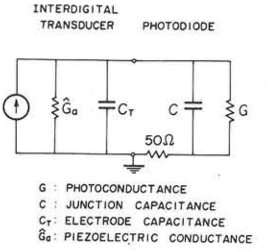


Fig.4 Equivalent circuit.

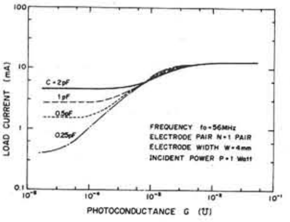
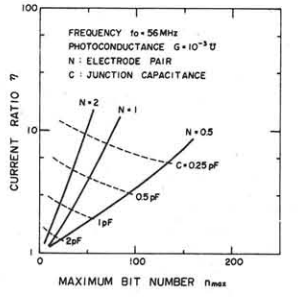
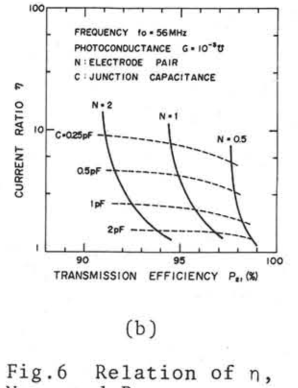


Fig.5 Calculation of load current v.s. photoconductance.



(a)



(b)

Fig.6 Relation of η, N_{max} and P_{21}

This type of devices has advantages of a simple structure which still furnishes high scanning speeds of up to several tens of MH_z with low input power of on the order of mW.

3 Acknowledgement

The authors are indebted to Dr. Murakami and Dr. Andoh for useful suggestion and Mr. Ishihara for preparing a photodiode array.

1) I. Kaufman and J. W. Foltz, Proc. IEEE Letters, pp2081-2082, November 1969

2) V. O. Blackledge et al, IEEE J. Solid-State circuits, 5, 5, p244-249, October 1970

3) W. Richard et al, IEEE Trans. MTT, MTT-17, 11, November 1969