A — 3 — 8 High density frame transfer image sensor

G.A. Beck, M.G. Collet, J.A.A. van Gils, A.J. Klinkhamer, P.L. Peek W.N.J. Ruis, J.G. van Santen, T.F. Smit, G.T.J. Vandormael

Philips Research Laboratories
Eindhoven-The Netherlands

From the moment of their conception Charge Transfer Devices have been expected to result in rugged, reliable and very compact image sensors, free from burn-in and lag problems. In recent years the state of the (research) art has advanced to a stage where single chip colour cameras with encourgaging picture quality have been demonstrated.

For this application the image sensors have to fulfil a number of requirements: a large number of picture elements is needed to achieve sufficient resolution as well as adequate colour information, a high sensitivity is necessary to record scenes indoors, objectionable blooming should be suppressed. At the same time the chip area has to be sufficiently small to make production feasable and ultimately profitable. None of the solutions demonstrated up till now satisfies all these criteria.

The sensor described in this paper is PAL compatible and delivers two interlaced fields of 288 lines each with 780 pixels per line.

The image section measures 8.58 mm (H) x 6.48 mm (V), the total chip 10.1 mm (H) x 11 mm (V), it is designed with 4 /um minimum dimensions.

The vertical CCD registers (bulk channel) are driven by three phase clocks, the electrode pattern consists of three poly-silicon layers. To obtain high blue sensitivity, phases one and two run horizontally across the sensor while they are crossed at right angles by phase three. This construction - together with partially self-aligned channel stops - results in an open window of 7 /um x 14 /um, the rest of the 11 /um x 22.5 /um image cell is covered by poly-silicon.

The storage section, where no windows are needed, is only half as large as the image section.

To fit the horizontal pitch (11 /um) of the vertical channels to the read-out register, three parallel read-out registers are provided. When the chip is used as a colour sensor this has the additional advantage that separate transport channels are available for the red, green and blue signals. The three output amplifiers each have only a 50 fF input node capacitance, resulting in high gain and low thermal noise. No anti-blooming overflow drains and barriers are provided, because their presence would have reduced sensitivity as well as packing density. Instead a charge-pumping mechanism is used to recombine excess electrons, generated by over-exposure, through surface states with holes from the

channel stop regions. Thus the channel stop regions, which are necessary anyhow, are used to carry off excess charges. We will report results obtained with this sensor using glued-on colour stripe filters, in addition results will be presented of a shrunken versio with the same number of picture elements on a chip of 90 mm^2 with 3.6 μm minimum dimensions.