New Products & Technologies

# Multi-function Image Processor*

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## 1 Introduction

The remarkable advance in automation equipment in recent years has created a marked trend toward higher function, miniaturization of equipment, and combination of functions. In tandem with this trend, there is an increasing demand for improved performance in the LSIs that structure this equipment. To meet these requirements, the authors have developed, as outlined in the following, a high-function, easy-to-apply image processor "multi-function image processor/KL5A20018" specific to system equipment such as facsimiles and image scanners.

## 2 Outline of Functional Specification

The KL5A20018, a multi-function image processor, is capable of realizing high picture quality on the strength of many image processing functions integrated thereon, including reduction and enlargement between 25 to 250% at 1% steps, as well as a 7 bit error diffusion method. Also included is a synchronous signal generation circuit and a control circuit for using an external SRAM as an image memory. The functional specifications are summarized in **Table 1**, and a functional block diagram is shown in **Fig. 1**.

Table 1 Specifications

| | |
|---|---|
| Clock frequency | 25.6 MHz |
| PIX processing frequency | 0.8 MHz |
| Input PIX data | 8~5 bits/pixel |
| CPU I/F | 8 bits |
| $\gamma$ correction RAM size | 256 words×8 bits |
| Dither RAM size | 64 words×8 bits |
| Input paper size | A3 (2432 pixels)<br>B4 (2048 pixels)<br>A4 (1728 pixels) |
| Resolution | 8 dots/mm |
| Input level | TTL |
| Output level | CMOS |
| Operating voltage | 5 V±5% |
| Package | 120 pin plastic QFP |

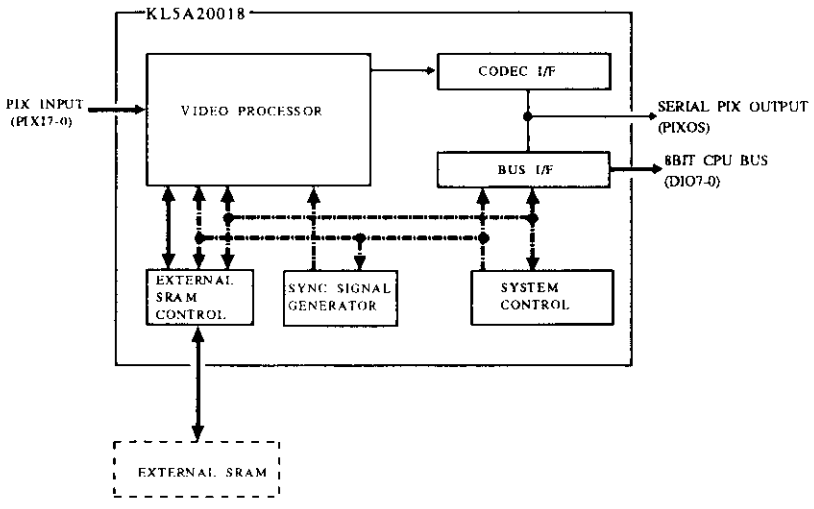


Fig. 1 Block diagram

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## 3 Outline of Image Processing Functions

This product is provided with ten image processing functions, which can be used for different purposes and applications. Each image processing function is outlined in the following:

(1) Shading Correction
Input image data contains shading distortions resulting from light deterioration at both ends of a lighting source or decrease in quantity of light in the periphery of the lens, and output variations dependent on pixel characteristics of the read device. Shading correction is meant to correct such shading distortions as described above and output variations of the read device pixels.

(2) Gamma Correction
Gamma correction, which makes digital correction of the gray level and tone of input image data.

(3) AGC Correction
For example, when a copy with a gray background with black characters written thereon is read out, it is extremely difficult to discern the characters if the gray background is reproduced as it is. Interpretation of such characters is facilitated by detecting the gray background and gradually lowering its gray level until it becomes white.

(4) Edge Enhancement Process
The two-dimensional (3 × 3) edge enhancement filter process improves the reproducibility of fine lines with low density. This function is particularly effective in reading copies containing many thin characters.

(5) Smoothing Process
The two-dimensional (3 × 3) smoothing filter process reduced image noise or dot patterns from a dot copy for reproducing a smooth image.

(6) Image Area Discrimination Process
In reading a copy in which texts and photographs (image data) are mixed, a discrimination process is employed to discriminate text and photograph areas in the copy for edge enhancement and smoothing of each area. The discrimination process uses a two dimensional (3 × 3) gray level gradient detection filter to detect the gray level gradient between a pixel to be discriminated and its peripheral pixels. Where the gray level gradient is sharp, it is discriminated as a pixel in the text area, and where the gradient curve is gradual, it is discriminated as a pixel in the photograph area.

(7) Error Diffusion Method
Density errors before and after a binary process are locally diffused for least approximation to make a clear reproduction of an image.

(8) Dither Method
A half tone image is reproduced by means of a ordered dither method using a 4 × 4 or 8 × 8 matrix. The process is particularly effective for image data subjected to smoothing process.

(9) Simple Binary Process
Input image data with a gray level higher than any preset threshold is output as black binary data, while input image data with a gray level lower than any preset threshold is output as white binary data.

(10) Reduction/Enlargement
Reduction and enlargement toward the horizontal scanning are performed at 1% intervals by means of interpolation. Reduction toward the vertical scanning is performed by increasing the copy transfer speed in accordance with the reduction ratio, or by removing image data for unnecessary lines. Enlargement toward the vertical scanning is performed by reducing the copy transfer speed in accordance with the enlargement ratio, or by repeatedly outputting image data for necessary lines.

## 4 Application Examples

**Figure 2** shows an example of system configuration. The KL5A20018 performs various image processing on 8–5 bit input image data from the image sensor (CCD/CIS), and the binary data of image processing results is supplied to a CODEC or a CPU bus.

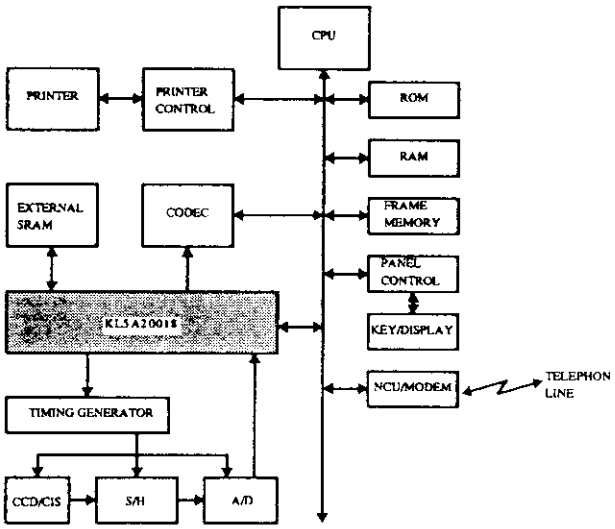


Fig. 2 Facsimile system

## 5 Concluding Remarks

The above outlines Kawasaki Steel's multi-function image processor KL5A20018, an LSI specific to image processing, and it is our intention to continue developing new products that meet market requirements.

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