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Large Integrated Circuit of a Linear Interpolator Based On a Basic Matrix Crystal

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***Abstract*—Peculiarities of construction of a large integrated circuit for a linear interpolator based on a basic matrix crystal are considered.**

***Keywords*—graphic primitives, linear interpolator, large integrated circuit, Basic Matrix Crystal.**

I. Introduction

Line segments have the greatest weight in the set of graphical primitives. In this regard, the algorithms of linear interpolation are paid special attention in the development of graphics devices [1-8]. Vector generators (linear interpolators) are widely used in computer graphics tools and numerically controlled machines.

The authors developed and manufactured a large integrated circuit (LIC) of a linear interpolator (Fig.1) using a basic matrix crystal (BMC) 1515XM. The integrated circuit has been introduced into serial production in a number of devices.

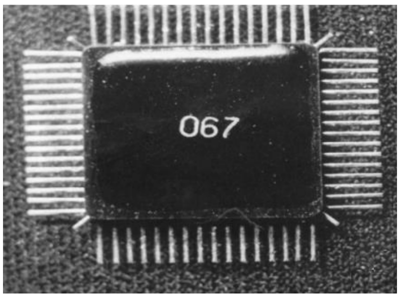

Fig. 1. Appearance of a LIC of a linear interpolator.

The main advantages of BMC: has a fixed geometric structure, which greatly simplifies the automatic placement and tracing of elements; developing LIC using BMC is performed with a small number of photo templates, which significantly reduces the cost of production of LIC; developed library of logical elements and standard circuit solutions significantly simplifies the process of developing a logical project, reduces design time; LICs based on BMC do not require qualification tests.

II. Description of the LIC of a Linear Interpolator

The LIC of the interpolator, which is implemented using the BMC 1515XM1, provides the following functionalities: formation of step increments of the coordinates of the line segment given by the coordinate increments; receiving of the initial coordinate of the line segment and formation of unit increments of the coordinates of the line segment, given by the coordinates of the end point; receiving and shifting the mask code with its issuance in the sequential code; equalization of the speed of segment formation depending on the slope of the line; control of issuance frequency of single increments of coordinates; receiving coordinates (increments) in different formats; receiving coordinates (increments) in direct or inverse codes; controlled suspension of line segment generation.

The developed linear interpolator is characterized by the following main parameters: power supply voltage - 4.5… 5.5 V; information retention time at information inputs relative to strobe signals - 100 ns; the minimum period of input sync pulses is 200 ns; bit rate - 12 binary digits; maximum current consumption in static mode - 1 mA.

Consider the algorithm and block diagram (Fig. 2), which was implemented in the LIC.

In the vast majority of cases, the method of estimating function [1, 8] is used to form straight line segments, the sign of which determines the position of the trajectory point relative to the straight line segment. The most common use of the method of estimating function for the formation of vectors is also due to the simplicity of the computational process, as well as the lack of "long" operations. The method provides maximum accuracy and uses as a basic microoperation of acumulative addition. The most common algorithms of the estimating function are the algorithms of Brezenham and Pietukh-Obidnyk [1, 2]. The algorithm of Pietukh-Obidnyk is the best because it provides a simpler calculation of the initial value of the estimation function and lower bit rate of the operating unit.

The formation of a segment of a straight line using algorithm of Pietukh-Obidnyk [1, 2] is conducted according to the formulas:

$$F_{i+1} = \begin{cases} F_i - SI, if \ \ F_i \geq 0, \\ F_i + \Delta, \ if \ \ F_i < 0, \end{cases}$$

where $F_0 = \lfloor LI/2 \rfloor$, $\Delta = LI - SI$, LI is the larger coordinate increment of the segment, SI is the smaller coordinate increment of the segment.

If $F_i \geq 0$, then the step on the main coordinate is performed. When $F_i < 0$, a combined step is performed (in both coordinates). This algorithm provides maximum accuracy (maximum error is equal to half the sampling step).

The block diagram of the operating part of the linear interpolator is shown in Fig. 2.

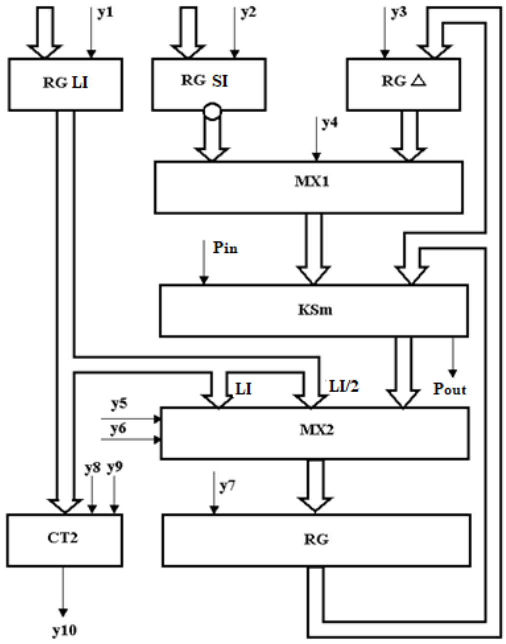

Fig. 2. Block diagram of the operating part of the linear interpolator.

The device includes registers RG for storing LI, SI and Δ, acumulative adder, which consists of a combination adder KSm and register RG , multiplexers MX , counter $CT2$. Larger (LI) and smaller (SI) increments are entered in the registes $RG\ LI$ and $RG\ SI$ from the input data bus D , respectively.

The value of LI via the multiplexer $MX2$ is entered in the RG of the acumulative adder (formed by the combination adder KSm and the register RG). Through the multiplexer $MX1$ the value of SI in the inverse code is fed to the input of the acumulative adder (since the subtraction operation for this case is performed in the supplementary code, the level of the logical unit is fed to the input of the acumulative adder), i.e. the data is read from the inverse outputs of the triggers that form the specified register. The value of $LI - SI$ from the output of the adder KSm is entered in the register $RG\,\Delta$. The value of the larger increment is fed to the counter $CT2$ from the output of the register $RG\ SI$, which is recorded in the counter under the action of the signal $y8$.

The value $\lfloor LI/2 \rfloor$ is fed to the RG register of the acumulative adder, which is obtained by assembing at the output of the multiplexer $MX2$. This completes the preparation cycle.

In the interpolation cycle the value of the estimating function is calculated in each tact. To do this, value Δ or SI is fed from the output of the multiplexer to the input of the acumulative adder.

The sign of the estimating function determines the transfer signal P_{out} of the adder. With each interpolation tact, the value of the counter decreases by 1. When the counter reaches zero, the interpolation process ends.

Conclusion

The developed LIC of the linear interpolator provides the maximum possible accuracy of reproduction of segments of lines in discrete coordinate space and formation of step increments in each tact.

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