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Design of Motion Control System Based on DXF Graphic File

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Abstract: The structure feature of DXF (Drawing Exchange Format) graphic file is analyzed in this study. According to its feature, information of lines and circles and arcs can be extracted through computer programming. The data is used for the interpolation to generate processing data and then, all processed data is sent to the microcontroller through the communication port once. The microcontroller receives data and stores them in the memory. When it works, the microcontroller reads the data from the memory and controls the driver to drive a stepper motor. The study introduces the motion control system.

Key words: DXF (drawing exchange format), motion control, design of system, stepper motor

INTRODUCTION

With the continuous development of modern economy, the CAD/CAM integrate technology become more and more important among enterprises. An important part of integrating CAD/CAM is how to extract the geometry information from the CAD file and convert to CAM information. According to actual demand, it can process the information to the data that can be directly used to control execute parts movement and the processing will simplify the system and the system can relieve the aim of quick develop and make all the scheduled functions come true (Tian and Liu, 2013). As a rounded graphics editing system, the AutoCAD software occupies an important position in the CAD field but it is hard for users to use the graphics' data information directly for its DWG file format adopts compact binary saving form (Chen and Chen, 2012). Therefore, the Autodesk company provided a drawing exchange file, namely DXF. DXF is a CAD data file format for data exchange between AutoCAD and other software. As an opening vector data format, DXF was classified into two formats: ASCII and binary. ASCII format with advantage of well readable but the disadvantage is occupying large space (Huang, 2007). The binary format occupies space smaller the ASCII and reading quickly but the disadvantage is readability is not strong. Because AutoCAD is now one of the most popular CAD systems, DXF file is also widely used. Mostly CAD system can input and output DXF file (Bidanda, 2009). DXF file contains the whole information of the corresponding AutoCAD graphic file (DWG format file). Owing to the DWG format drawing file's data structure is the Autodesk Company's commercial secrets, some processing CAD drawing professionals often hope to read and write DWG

format file directly but it seems complex and difficult in some extent (Bordignon and Stoy, 2009). DWG format file is binary format and can be converted into DXF format file by the inner-converter of AutoCAD, thus it'll easily achieve reading and writing data (Shen *et al.*, 2006).

The rest of this study is organized as follows. Section 2 presents the structure analysis of DXF file. The extract data and calculate interpolation are explained in section 3. The design of serial port communication is given in section 4. Section 5 presents the design of single chip system's software and hardware. The function is realized in Section 6. Finally, Section 7 gives the concluding remarks.

STRUCTURAL ANALYSIS OF DXF FILE

The content of DXF file is organized by "SECTION", each section start with group code "0" and character string "SECTION" and end up with group code "0" and character string "ENDSEC". All content is divided into the following "SECTION": HEADER (the general information of the figure), CLASSES (the class information), TABLES (the definition of naming clause), BLOCKS (the definitions of blocks), ENTITIES (the drawing entity), OBJECTS (non-graphic data), the EOF (END OF FILE).

The aim of extracting data from DXF file is to obtain the drawing data for interpolation algorithm. These data is for drawing graph, including definition of the line, circle and circular arc. According to the structural analysis of the file, the data that require extracting is saved in ENTITIES section and this section covers all the geometry data for drawing lines.

For two-dimensional figure, there are four data to define lines in the file, namely the X, Y coordinates value of the line's starting point and ending point. In the file,

the string "AcDbline" is the begin of defining the line, "10", "20" and "30" is the line's starting label of X, Y, Z coordinate, "11", "21" and "31" is the line's ending label of X, Y, Z coordinate. Because of the drawing is two-dimensional figure, so the coordinate value of Z orientation is 0.

For two-dimensional figure, there are three data to define circles in the file, namely the X, Y coordinates value of the circle's center and radius. In the file, string "AcDbCircle" is the beginning of defining circle.

For two-dimensional figure, there are five data to define circular arc, namely the X, Y coordinates value of the circular arc's center, the radius value, the starting and ending angle value of the circular arc. Therefore, the circle can be seemed as a special circular arc except its starting and ending angle value is 0° . Actually the define of the circular arc is under the circle. That is to say, if it is circular arc, after define the circle's three data, next step is define the data of the starting and ending angle value of circular arc. If it is circular arc, the string "AcDbArc" will be written after define of circle, "50", "51", respectively

represent the label of the starting and ending angle. The measure of the starting and ending angle value is all based on the direction of X coordinate.

EXTRACT DATA AND CALCULATE INTERPOLATION

That can be seen from the preceding analysis; the DXF format is sequential file, so take the mode of sequential access to read. Read the record line by line, according to the string of defined line to estimate whether read out the data of the line defined or not. The whole operate flow of reading out the data is as shown in Fig. 1.

As the beginning of interpolation, the first step is to read the first line's data from the file which used to save lines. If the line is straight line, call the line interpolation program. If it is circular arc, call the circular interpolation program. According to the circular arc's data, the starting and ending point will be calculated, the point determined by the starting angle is the starting point, the point determined by the ending angle is the ending point.

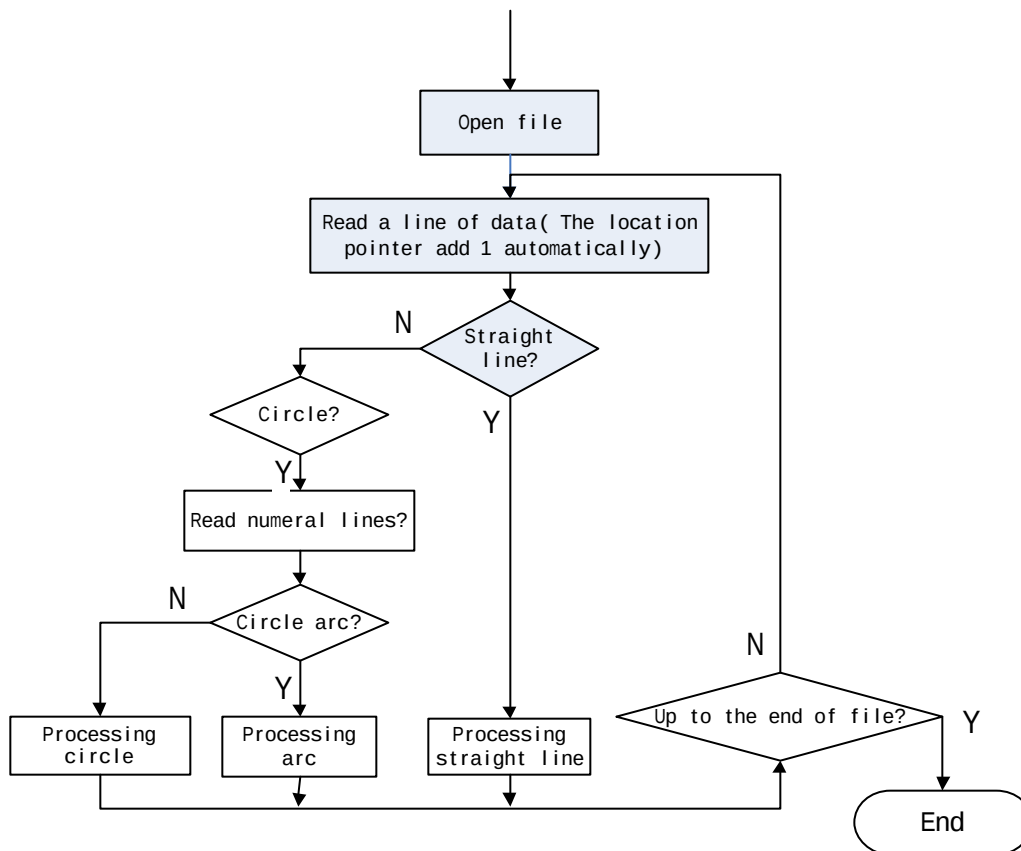


Fig. 1: Flow chart of extracting data

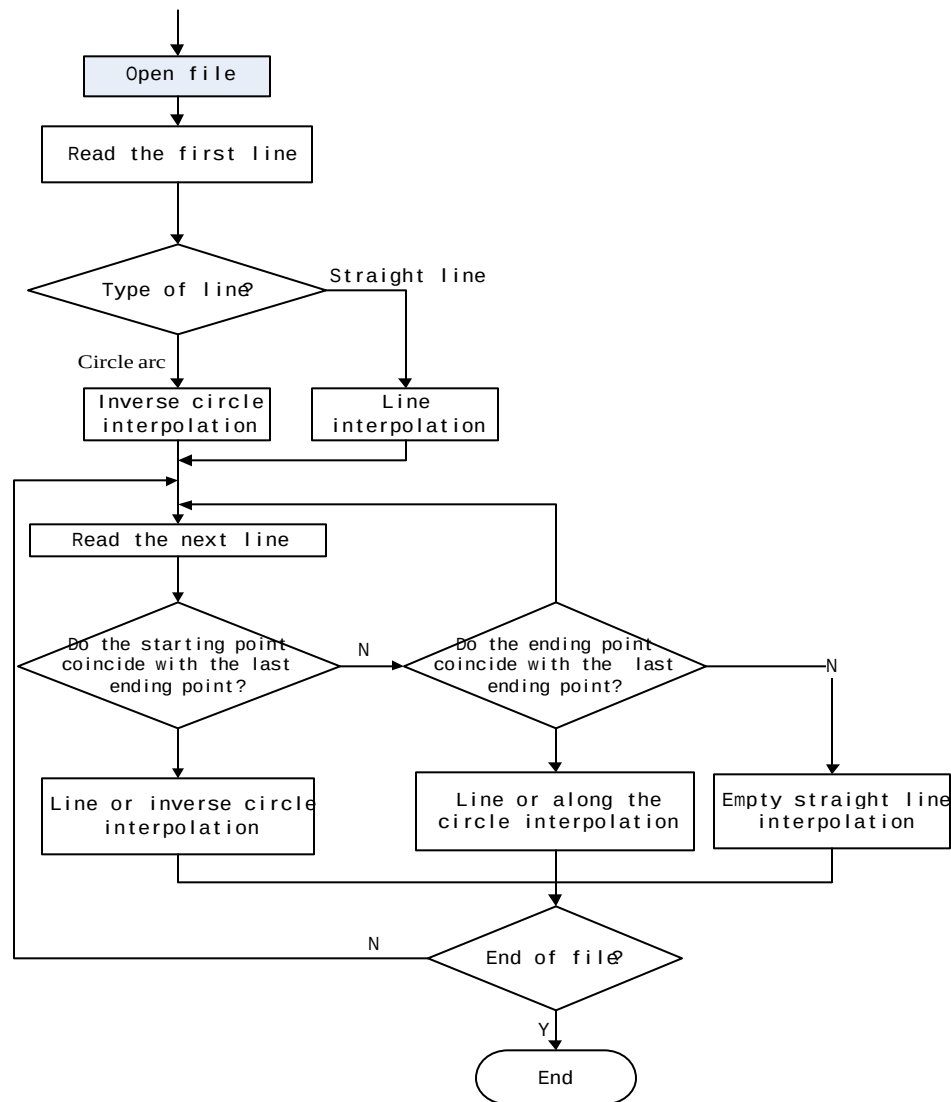


Fig. 2: Flow chart of interpolation program

Therefore, it should call for the inverse circle interpolation program when read the first circular arc. In the next read the data of line and verdict the relationship of it and the ending point of last line.

If the starting point of current line is coincided with the ending point of last line, it needs line or inverse circle interpolation. If the ending point of current line is coincide with the ending point of last line, it need line or circle interpolation. If it doesn't satisfy the two conditions described upon, it needs to go alone to the starting point of next line. When execute the process above, read the data from the beginning to the end until finish all the lines interpolation. The whole operate flow is shown as Fig. 2.

DESIGN OF SERIAL PORT COMMUNICATION

The epigenous machine and lower machine of system design usually adopt serial port communication and use the RS-232 serial interface of 9Pin. The connection mode of RS-232 is as Fig. 3. Usually the serial port need to initialization before use. If necessary, it also needs to set the size of send buffer and receive buffer and clear these two buffers. Therefore, the initialization flow before the serial port sent data is as shown in Fig. 4. In the process of transmission, the data may encounter some interference and make the original data signal distort, obviously the result data is wrong. In order to detect the errors in the process of transferring, the transfer side and receive side

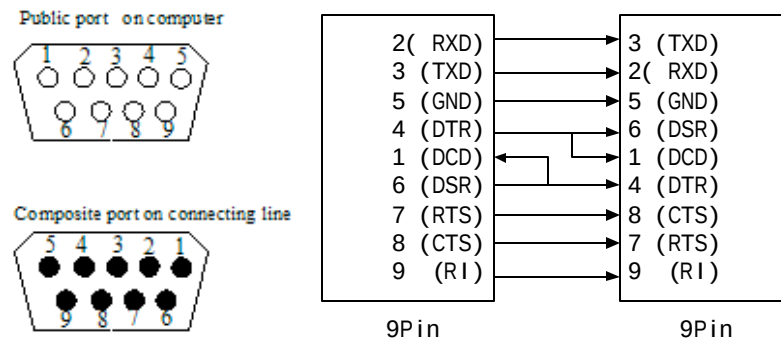


Fig. 3: Foot wiring diagram

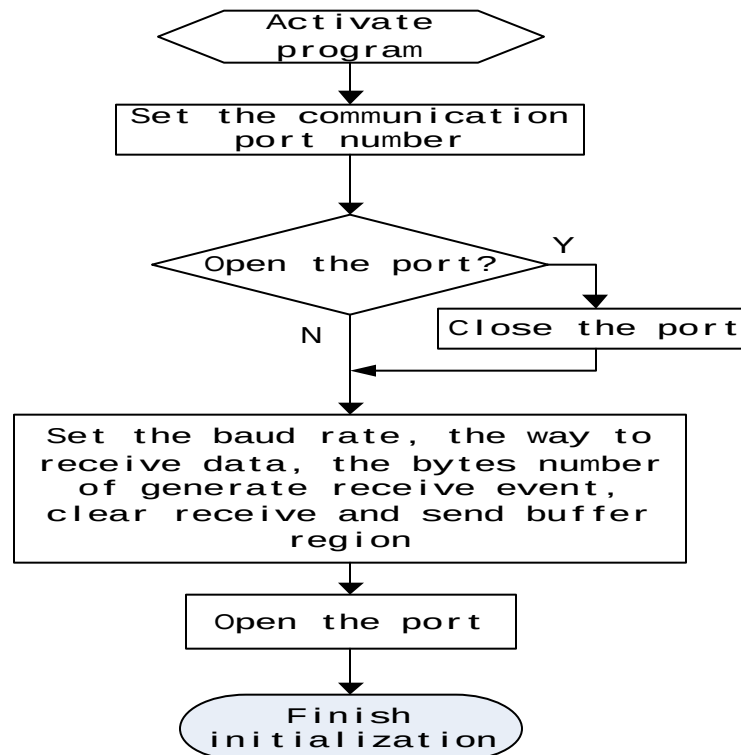


Fig. 4: Flow chart of serial initialization

should do the conform work for data, the simple way is to use check code. Generate check code has a variety of ways, commonly used like the Checksum and CRC (Cyclic Redundancy Check); this designing system uses the CRC to check code.

DESIGN OF SINGLE CHIP SYSTEM'S SOFTWARE AND HARDWARE

The single chip C8051F340 device of this system use CIP-51 microcontroller core which is the patent of Silincon Labs.

This device adopts pipeline structure and its speed of executing command is greatly improved compared with the standard 8051 structure. All the commands of the standard 8051 structure need twelve or twenty system clock cycle except the MUL and DIV command and the maximum rate of system clock cycle is 12-24 MHz.

Minimum system of single chip: The schematic diagram of the minimum system of single chip is as shown in Fig. 5 and the power output 5V of regular voltage. There is a programmable internal high rate oscillator, a programmable internal low rate oscillator, an external

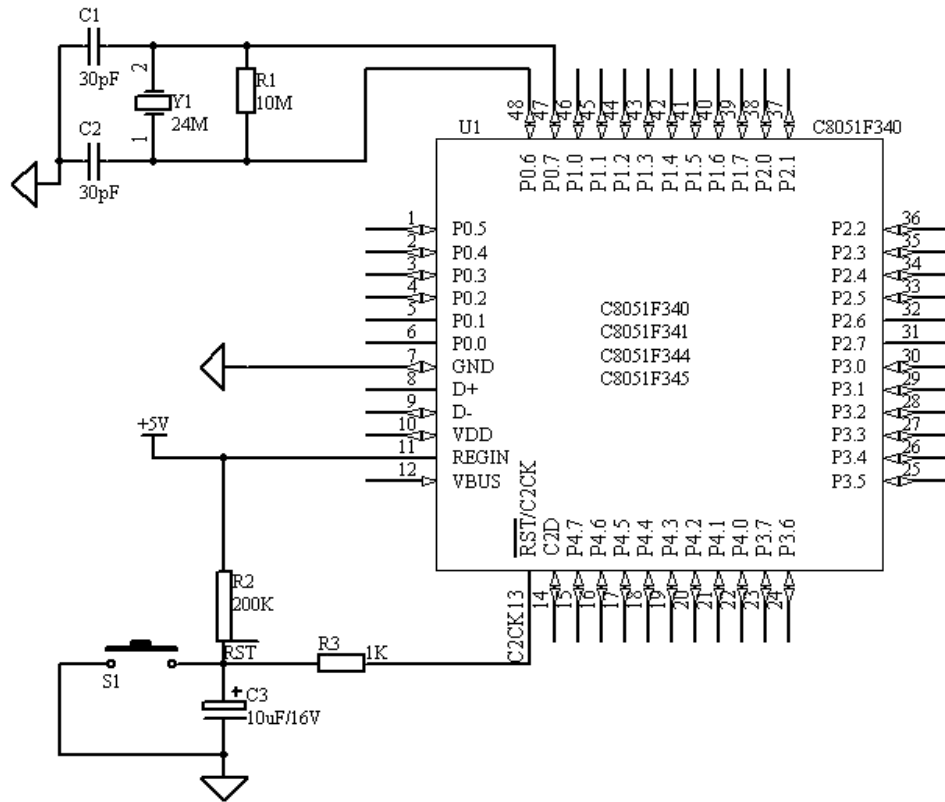


Fig. 5: Schematic diagram of the minimum system of single chip

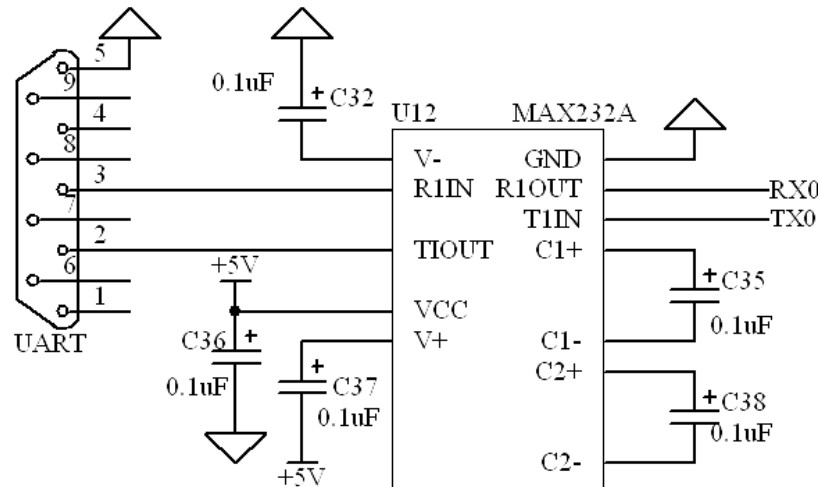


Fig. 6: Electric schematic diagram of serial module

oscillator driving circuit and a quadruple clock multiplier in single chip C8051F340 device. The system's external oscillator circuit adopts the 24 M crystal oscillator. The reset circuit can realize automatic reset and manual reset under electricity. The development port of

Silicon Labs' C2 line can use develop environment to debug MCU under noninvasive way (not occupy the resource of interface) and all online. The debug logic support observe and modify storage and register and support break point, single step, run and shutdown

machine command. When use C2 to debug, all the simulations and digital external devices can run with all the functions. The two C2 interface pins can share with user function.

Serial module: RS-232 only uses threes lines: Sent line, receive line and signal ground. It must comply with the rules of connecting the sent line of one side with the receive line of the other side. Due to the computer serial port output electrical level is high to +12v and low to -12v but the single chip TTL electrical level is +5v as equal to logic "1" and 0v is equal to logic "0", so it is necessary to use a electrical level converter chip MAX232A. The role of MAX232A chip is to convert the TTL electrical level to 232 electrical levels which the PC can receive and vice versa.

Design the single chip serial port communication program: The serial port program of lower machine mainly refers to the data receive program. According to the communication contract, the first byte of data that with different uses is used to identity the meaning of data and dispose the next data. The main task of processing receives and dispose data of serial communication program is that receive a specified number of processing

data and store it as a whole. Here, for the processing data bytes of straight line and arc are different, so it need to save, respectively and the logo for the first byte. The byte of control command and manual instruction firstly transmit by serial port and then estimate its value, lastly disposes it based on the value. If receives the control command, it may take the operation of data receive, launch, stop and other operations. When receive the manual instruction, its data determine the timer's pulse output rate and the state of direction control the pin.

REALIZE THE FUNCTION

The development environment of epigynous machine is under VB6.0, the program realize the functions like extracting data, displaying graph, interpolation arithmetic and serial port communication. The function module on man-computer interface is the epigynous machine's software operation platform. The test method is that the lower machine will send the data to the epigynous machine after receive the data from it. The epigynous machine will show the data in the textbox when receive the data. The effect of function realization is as shown if Fig. 7.

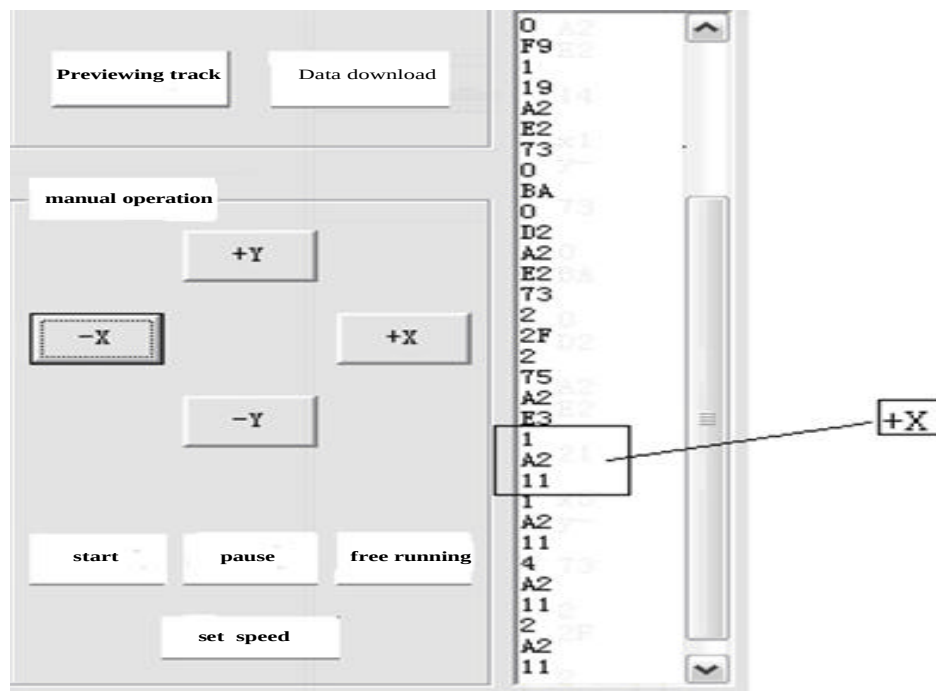


Fig. 7: Epigynous machine's software operation platform

When click the "Data Download" button, the epigynous machine will send the data to the lower machine and the lower machine will receive and save the data. When click any button of the "Manual" textbox, the epigynous machine will send the corresponding command to the lower machine. For example, if click the "+X" button, the epigynous machine will send "0x01" and "0xA2" (speed) to the lower machine when the button is continual pressed on but if release the button, the epigynous machine will send "0x11" to the lower machine. The right textbox shows the data of the epigynous machine returned.

CONCLUSION

This study makes a detail analysis for the structure of DXF format file, designs a motion control system for controlling the lower machine and extracting and interpolating data which based on DXF drawing and programming the epigynous machine' man-computer interface and data disposing. The man-computer interface includes display data and software operation platform. The data disposing program includes extract drawing's data, display the drawing and interpolate arithmetic program. The effect of interpolate arithmetic is tested by software and the result of the lower machine's program is tested by the oscilometer. The entire programs are optimized, simple, clear and easy to maintain. The system can realize the expected function under the debugging.

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