Metamation

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LASER CORE 800 CONTROLLER PROGRAMMING MANUAL

Version 1.61

	Name	Date	Signature
Prepared by	Sasi Kumar C	05-05-2020	

Revision Control:

Version	Comments	Date
V1.0	Initial release	05-05-2020
V1.1	i. Cancel compensation chapter. ii. Block number for closed contours only	09-05-2020
V1.2	i. Updated Program Header & End for Bound Check Program ii. Updated Number of Piercing methods iii. Added 'Lead IN Retrace' option in Cutting methods. iv. Added Fly Cut / Stitch cut	24-06-2020
V1.3	i. Updated Focus Ramp Piercing to Nozzle Height Ramp Piercing ii. Updated Machine Orientation	03-07-2020
V1.4	i. Added – Only Piercing code ii. Added – Block Number in Din code iii. Updated – Program header with M15	13-07-2020
V1.5	i. Added – CNC ID, XY program limit values & M50 command in Program header. ii. Re-arrangement of Program header. iii. Added – Block Number in Din code iv. Added – 'Remnant cut' option in Cutting methods. v. Added – 'Beam Off' option in End methods. vi. Tool offset saved in P1300 is named as "Kerf" in G41/G42 command vii. Added – new chapter Remnant Cut	13-01-2021
V1.6	i. G253 & H0 command should be in 2 lines for TT transfer (required for Vulcan) ii. Add E0 in G253 command for PLC read. iii. Added additional parameters in TT	18-05-2021
V1.61	i. Remnant cut sample code is wrong, CM=102.110, instead of CM=102.020 is updated	18-08-2021

Contents

1 Introduction

1.1 DIN Standards

DIN stands for “Deutsches Institut für Normung”, meaning “German institute for standardisation”.

CNC related DIN standards are as follows:

- DIN 66025-1 Numerical control of machines, format; general requirements.
- DIN 66025-2 Industrial automation; numerical control of machines; format, preparatory (G-codes) and miscellaneous (M-codes) functions.

Some of the Standard G-codes used in DIN 66025-2 are listed below for quick reference:

- G00 – Rapid traverse
- G01 – Linear interpolation with feed rate
- G02 – Circular interpolation (clockwise)
- G03 – Circular interpolation (counter clockwise)
- G04 – Dwell time in milliseconds
- G17 – Selection of the X, Y plane
- G18 – Selection of the Z, X plane
- G19 – Selection of the Y, Z plane
- G20 – Block Jump
- G40 – Path compensations “off”
- G41 – Path compensation left of the work piece contour
- G42 – Path compensation right of the work piece contour
- G61 – Stop Pre-processing of block
- G90 – Absolute programming
- G91 – Incremental programming

1.2 Scope of the document

This document describes how a DIN program must be structured for the "cutting" technology, to make an interpretation possible of the DIN program by the **LASER CORE 800** CNC controller and to correctly implement the programmed travel and control commands.

Programming of the CNC controller is made referring to DIN 66025. When compared with DIN, however, the instruction set is clearly larger. A wide range of additional, efficient functions is available which will be explained in this document on the basis of examples.

2 DIN Program Structure

A program consists of a program number, a number of blocks, and the end of program. Beginning of program and end of program represent the minimum contents of a program. A program may contain any number of blocks. The only limitation to the program size is the total memory size available. In addition to the (optional) block number, a block consists of a statement.

A statement contains the elements:

- preparatory function **G**
- auxiliary function **M, S, T**
- high-speed outputs **Q**
- parameter assignments
- arithmetic instruction
- comment

Points to remember:

- ✓ Each element (G or M code) must be programmed only once in a block. *High-speed outputs* and *parameter assignment* are an exception.
- ✓ A block must have max. 256 characters. A block may also contain comments.
- ✓ Within a program, block numbers must be assigned in ascending order.
- ✓ A comment must be at the end of the block or stands on its own in a block and is delimited by parenthesis or, in case of arithmetic instructions, by braces.

2.1 Program Number %

A program usually begins with a **%** character that is followed by the program number ranging from 1 through 9999 maximum. Each program can be directly started or be called as a subroutine by other programs. Main program and subroutines cannot be discriminated by their program numbers, but by the end of program statement:

The end of program is marked by the corresponding M function or G function:

- M30 = End of main program
- G99 = End of subroutine

Program numbers ≥ 8000 are usually considered separately. This range is normally used for storing cycle programs.

2.2 Block number N

Block numbers are optional. This means that each block can have a preceding block number assigned. Within a program, block numbers must be assigned in ascending order. Block numbers are only required for specifying a target block for program loops and/or branches. The blocks are executed in the programmed sequence.

For a block number, the numbers 0 ...65535 (= 2^{16}-1) are allowed. This means that block numbers > 65535 are interpreted possibly no more in a raising sequence but will be denied with a fault message.

2.3 G-functions

On principle, a DIN block with a G-function has the following structure. The letter G is followed by the number of the G-function. Then the parameters follow which are formed by their address letter and the respective value:

G(number) [address identifier (address value)]...

Example: G0 X0 Y0

All addresses may also be programmed indirectly as an alternative to the direct input. This is shown by the specification of P. The value of the parameter array of the specified index is assigned to the address letter instead of a numerical value.

Example: G0 X=P5000 Y=P5001

2.4 M-functions

Pre-programmed functions can be activated in the controller by means of M-functions. The M-functions are sent to the PLC, interpreted and the required function is activated. The M-command 0 – 500 are Synchronous and >500 are Asynchronous commands.

Example: M30 (Program End)

2.5 Parameter Array

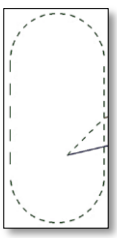
A data array is available in the controller for the programming with variables, the so-called parameter array (P-array). The P-array values can be defined globally and use the name in the program for easy identifications. Their use is described in the following chapters.

Example: #globdef Sheet_Size_X P1900 (Sheet Size along X-axis)

2.6 Graphical Element – Display Marker Lines

It is possible to display dashed marker lines in the HMI in the DIN program display. Insert the respective graphical marks before and after the contour which is to be shown dashed and applicable only for STDHMI.

{LB,K0} (Start Line display)
G1 X124.5 Y35.5
G3 X115.5 Y35.5 I-4.5 J0
G1 X115.5 Y24.5
G3 X124.5 Y24.5 I4.5 J0
G1 X124.5 Y30
{LE} (End Line display)



In the DIN program display, the contour which is to be marked is showed in dashed lines for better understanding of the operator.

3 Laser Technology

Depends on the technology, the DIN program structure can be modified to suit the requirements of the user. Using the Laser Core 800 CNC controller, a DIN program for the Laser technology is composed of following:

- ***Program Header***
- ***Technology Table Transfer***
- ***Block Jump***
- ***Block Number***
- ***Start of a Part Information***
- ***Laser parameters selection & Update***
- ***Contour statements***
- ***Program End***

Example Program:

%1 (PP_Sample_Pgm.DIN) *CNC_ID=1* *Sheet_Size_X = 120* *Sheet_Size_Y = 600* *Job_Size_X = 105* *Job_Size_Y = 573* *X_Limit_Minus = 10* *X_Limit_Plus = 115* *Y_Limit_Minus = 10* *Y_Limit_Plus = 583* *G90* *M15* *CheckBoundPrg*	Program Header
G253 F="TT:MS_1mm" E0 *H0*	Technology Table Transfer
G20 X1	Block Jump
N1 BlockNo=1	Block Number
M01	Start of a part information if any
PM=20.000 CM=100.000 EM=1.000 ZRH=20 Update_Param	Laser parameters selection & Update

G61 Lead_In=4.374 G41 R=Kerf E0 G0 X57.018 Y461.5 M14 (Laser ON) G1 X59.395 Y459.163 G3 X60.333 Y459.167 I0.467 J0.475 G3 I-2.828 J2.828 M15 (Laser OFF) G40 E1	Contour Statements
G99 N65535 CallBoundPrg G99	Program End

3.1 Program Header

The program header is the start of the program and executed only once during program running and it consists of following:

- ***Program Number***
- ***Program Name as comment***
- ***ID of the Controller (Tandem operation)***
- ***Program Specification***
- ***XY Program Limits***
- ***Program Dimensioning***
- ***Dual head Synchronization (Tandem operation)***
- ***Check Work Offset & Special functions***
- ***Check for Bound Program active***

Structure:

%1 (Sample.DIN)	Program Number & Program Name as comment
CNC ID	ID of the Controller (1 or 2)
Sheet_Size_X	Program Specification
Sheet_Size_Y	
Job_Size_X	
Job_Size_Y	
X_Limit_Minus	XY Program Limits
X_Limit_Plus	
Y_Limit_Minus	
Y_Limit_Plus	
G90	Program Dimensioning (ABS)
M50	Dual head Synchronization
M15	Check Work offset & Special functions
CheckBoundPrg	Check for Bound Program active

3.1.1 Program Number

The program number is always assigned with the value %**1.** Since all the Laser technology programs are assigned as Sub Programs and called from the Main program using the number **1**. Hence it is important to make sure the program number.

- ✓ ***Program Number must be always %1***

3.1.2 Program Name

The program name is defined in the program as a comment and will be useful for block search functions. Depends on the name, the PLC will save the current block numbers, Co-ordinates, etc., of the program and when loaded again, their respective values are retrieved from the PLC.

- ✓ ***Program Name must be in comment***

3.1.3 CNC ID

For Dual head tandem operation, 2 programs will be generated for a single job and the CNC ID will specify which program to be loaded in the controller as follows:

i. CNC_ID = 1, will contain the first half of the program and to be loaded in the controller, where the X-axis machine origin point starts.

ii. CNC_ID = 2, will contain the second half of the program and to be loaded in the controller, where the X-axis machine positive stroke limit is possible.

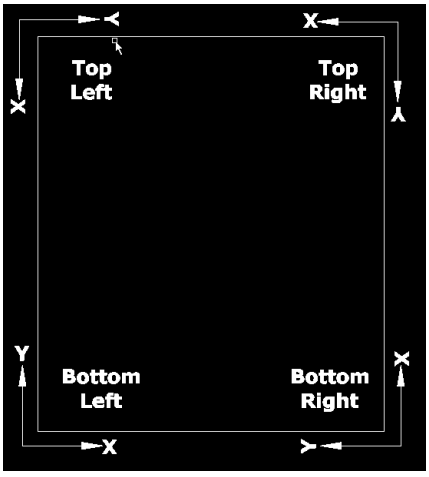
The Values are assigned to P-fields and for better understanding the P-fields are ***globally declared internally*** in the program as follows:

#globdef *CNC_ID P1909*

- ✓ **The CNC_ID is required only for Dual head tandem operation**

3.1.4 Program Specification

The program specification defines the sheet size & Job size along X & Y axis. Based on the Machine Origin, the positive or negative sign in the size to be indicated.



- Bottom Left = X+, Y+
- Bottom Right = X+, Y-
- Top Left = X-, Y+
- Top Right = X- Y-

The Values are assigned to P-fields and for better understanding the P-fields are ***globally declared internally*** in the program as follows:

#globdef *Sheet_Size_X P1900*
#globdef *Sheet_Size_Y P1901*
#globdef *Job_Size_X P1902*
#globdef *Job_Size_Y P1903*

- ✓ **This information will be useful for Scrap cut & Boundary check programs**.

3.1.5 XY Program Limits

The X & Y-axis program limits are defined to ensure the machine strokes are within the limits. They are most useful in Dual head tandem operation, where a single job is separated between 2 heads and their limits are defined for the safety, boundary check program and Auto Lubrication program .

The Values are assigned to P-fields and for better understanding the P-fields are ***globally declared internally*** in the program as follows:

#globdef *X_Limit_Minus P1910*
#globdef *X_Limit_Plus P1911*
#globdef *Y_Limit_Minus P1912*
#globdef *Y_Limit_Plus P1913*

- ✓ **This information will be more useful for Dual head tandem operation**

3.1.6 Program Dimensioning

The program dimensioning defines the dimensions of axes in the program is absolute or incremental.

Syntax: ***G90/G91***

3.1.7 Dual Head Synchronization

If there is any dual head tandem operation, then 'M50' command will synchronize between two controllers and check for the program name, work offset etc., and then proceed further for cutting.

Syntax: ***M50***

- ✓ **The M50 command will be used only for Tandem Operation, else not required**

3.1.8 Check Work Offset and Special functions

The first M15 command in the program will check for the following:

i. With captured work offset and job size, the maximum stroke limits of X & Y axis in the program are calculated and then cross checked with their end limits. If the Stroke are within the limits, then proceed further else the program will be aborted.

ii. Check for any special sub program functions such as Nozzle cleaning, Auto lubrication etc., is active before start of the cutting. Generally, during normal cutting, if any of the special functions are active, they will wait for M15 command where the tool will be up.

Syntax: ***M15***

3.1.9 Check for Bound Program Active

The outer boundary run of the job can be checked for the current work offset, if required the offset can be changed:

The check for activation of Bound program is defined internally as follows:

***#globdef** CheckBoundPrg G20 X65535 E46*

If the Outer Bound program is selected, the Q-bit 46 (E46) will be activated in PLC.

So, when the main program is started, it will jump to Block number N65535 (it is the maximum value) to run the outer bound program.

3.1.10 Program Header Example:

%1 (PP_Sample_Pgm.DIN)
CNC_ID=1 (Only for Tandem Operation)
Sheet_Size_X = 120
Sheet_Size_Y = 600
Job_Size_X = 105
Job_Size_Y = 573
X_Limit_Minus = 10
X_Limit_Plus = 115
Y_Limit_Minus = 10
Y_Limit_Plus = 583
G90
M50 (Only for Tandem Operation)
M15
CheckBoundPrg

3.2 Technology Table (TT) Transfer

The Technology Table will contain all the parameters (details in further chapters) required for Laser cutting, depends on Material type, Thickness etc., Hence for the selected program, the TT need to be transferred to the controller via the P-array parameters by the HMI.

Hence the program need to contain the information about the material type and thickness, such that it is transferred to HMI to select the parameters from the database.

Using G253 command with E0, the information is passed to PLC from the DIN program, followed by H0 command which will send a message to HMI with all required data of TT and will be waiting for the acknowledgement from HMI for the successful transfer of parameters. It will be executed at the start of the program for one time.

Syntax: G253 F="TT:MS_1mm_O2_NONE_NONE_1.2mm" E0
H0

The data in the inverted colons refer as follow:

TT – Technology Table

MS – Material Type (will be varied depends on the selection of material)

1mm – Material Thickness (will be varied depends on the selection of thickness)

O2 – Gas type

Surface Treatment – None

Film coating – None

Nozzle Diameter – 1.2mm

E0 – PLC will read the Message and transfer the data to Vulcan via 'HMIAppMsg' to transfer the TT to P-fields

For more information refer ***"Laser Parameters in DIN program"*** manual.

3.3 Block Jump

The ***G20*** function is used for programming a jump within a program. In normal condition, the block jump statement will contain the successive block number, such that the program will run continuously without any jump.

Syntax: ***G20 X1 (Jump to N1 – block number)***

- ✓ ***This function will be useful for skipping a particular block or a part***

3.4 Block Number

Every start of the contour will contain the block number for easy identification of the contour, tracking of error in the program etc., For Block Search function, the block number need to be written to P-field (**BlockNo**, internally defined the P-field) for easy identification of blocks to transfer the parameters to the PLC.

Syntax: ***N1***
BlockNo=1

- ✓ ***The Block number should be specified for a Closed contour only. If any closed contour is split into more than one, then all should lie in same block number.***

- ✓ ***Refer the above chapter for details of the block number.***

3.5 Start of a Part information

In a Nesting/Layout jobs, a program may contain different parts to be processed and in-turn each part will have more than one block of contour. In order to identify the start of a part in the block number, the ***M01*** command is used.

Syntax: ***M01***

In general, the M01 command is an Optional Stop command and will be useful for the operator to stop the program before the start of a new part. Such that they can inspect the previous job for any corrections and update for further parts in the program.

In future, the information can be extended to handle the Scaling of the Part, Part count etc.,

3.6 Laser parameters selection & Update

Before the start of processing the Laser technology for a contour, it is important to select the suitable parameters for the particular contour and update it. These parameters will be updated for every contours in the program.

The functional parameters of Laser technology are as follows:

- Piercing Method (PM)
- Cutting Method (CM)
- Ending Method (EM)
- Z_Retract_Height (ZRH)

The parameter values are stored in the P-fields and for better understanding the P-fields are ***globally declared internally*** in the program as follows:

***#globdef** PM*	*P1904*
***#globdef** CM*	*P1905*
***#globdef** EM*	*P1906*
***#globdef** ZRH*	*P1907*
***# globdef** Update_Param*	*G22 L9400 (will call %9400 sub program to update parameters)*

Parameter Structure:

PM=20.000 CM=100.000
EM=1.000 ZRH=20
Update_Param

3.6.1 Piercing Method

The Piercing methods are defined based on the combination of different types of piercing available.

i. The Piercing methods are defined as Floating numbers = 20.123
ii. The numbers before the decimal point represents the **"Piercing ID"**
iii. The numbers after the decimal point represents the **"Piercing AID"**

Piercing ID:

S. No.	ID	Description
1.	0	No Piercing
2.	1	Normal Piercing
3.	2	Gentle Piercing
4.	3	Peck Piercing
5.	20	Multiple Step Piercing
6.	21	Multiple Step + Peck Piercing
7.	22	Power varied Ramp Piercing
8.	23	Duty varied Ramp Piercing

9	24	Nozzle height varied Ramp Piercing
10.	30	Dot Punch Piercing

Piercing Aid:

1st digit: Height Ctrl, Beam OFF, Cool time	2nd digit: Side Air Blow, Burr Clean	3rd digit: Free
0 = All Function disable	0 = All Function disable	0 = All Function disable
Bit0 = 1 = Height Ctrl ON	Bit0 = 1 = Side Air Blow ON	--
Bit1 = 1 = Beam ON	Bit1 = 1 = Burr Clean ON	--
Bit2 = 1 = Cool time OFF	Bit2 = 1 = Free	--

For more information refer ***"Laser Parameters in DIN program"*** manual.

3.6.2 Cutting Methods:

i. The Cutting methods are defined based on process & length of contours.
ii. The Cutting methods are represented as Floating numbers = 123.123
iii. The numbers before the decimal point represents the **"Process Methods"**
iv. The numbers after the decimal point represents the **"Miscellaneous Control"**

Process Methods:

1st digit: Process	2nd digit: Contour	3rd digit: Distance Regulation
0 = No process	0 = Large contour	0 – Height Control (HC) ON
1 = Cutting	1 = Medium contour	1 – HC Freeze in Lead-In & ON during Cutting
2 = *Special Cutting	2 = Small contour	2 – HC ON Positive direction & OFF Negative direction
3 = Marking	--	3 – Height Control (HC) OFF
4 = *Special marking	--	--
5 = Vaporization	--	--

Miscellaneous Control:

1st digit: Lead IN, Hole & Fly	2nd digit: Retrace	3rd digit: Free
0 = All Function disable	0 = All Function disable	0 = All Function disable
Bit0 = 1 = Lead IN	Bit0 = 1 = Lead IN Retrace	--
Bit1 = 1 = Pre-Hole	Bit1 = 1 = Remnant Cut	--
Bit2 = 1 = Fly control	--	--

For more information refer ***"Laser Parameters in DIN program"*** manual.

3.6.3 Ending Methods:

The Ending methods are defined based on the retract distance of Z-axis along with the Frog jump, HC freeze, etc., at the end.

i. The Ending methods are defined as Floating numbers = 20.123
ii. The numbers before the decimal point represents the **"End ID"**
iii. The numbers after the decimal point represents the **"End control"**

End ID:

S. No.	End ID	Functions
1.	1	Beam OFF, Z-axis retract = P1906
2.	2	Beam OFF, high voltage OFF, Z-axis to home position
3.	3	Beam OFF, Z-axis remains at the same processed height for the next process. Internally in the PLC, it will be moved to the minimum In-range distance for safety reasons

End Control:

1st digit: Frog Jump, Freeze HC, End Param	2nd digit: Not used	3rd digit: Not Used
0 = All Function disable	0 = All Function disable	0 = All Function disable
Bit0 = 1 = Frog Jump	Bit0 = 1 = Beam OFF	--
Bit1 = 1 = Freeze HC	--	--
Bit2 = 1 = End Parameter	--	--

For more information refer ***"Laser Parameters in DIN program"*** manual.

3.7 Contour Statements

This part of NC code contains the axis motion blocks and before that it prepares the above blocks with all required parameters ready to process the contour. They are further classified as follows:

- ***Stop Pre-processing (G61)***
- ***Contour Lead-In length (Lead_In)***
- ***Activate Kerf compensation (G41/G42)***
- ***Approach contour (G0/G1)***
- ***Laser ON function (M14)***
- ***Process contour (G1, G2, G3)***
- ***Laser OFF function (M15)***
- ***Cancel Kerf compensation (G40)***

3.7.1 Stop Pre-processing

The ***G61*** function can be used for temporarily stopping the block preparation of the interpreter. This means that the interpretation of the next block is stopped until the last block in the coarse interpolator's job buffer has been processed.

Syntax: ***G61***

3.7.2 Contour Lead-In length

In Laser technology, each contour is processed with some lead-in for better finish of the contour. It is possible to process the lead-in length with different laser parameters and it is activated via cutting method as explained above.

The lead-in length value is stored in the P-fields and for better understanding the P-field is ***globally declared internally*** in the program as follows:

#globdef *Lead_In* *P1908*

Syntax: ***Lead_In = 5.0***

3.7.3 Activate Kerf compensation (G41/G42)

In Laser technology, the width of the beam diameter need to be compensated in order to achieve the perfect dimensions of the contour. Depends on the size of contour defined in the program, the kerf will be changed.

The Kerf-width value is stored in the P-fields and for better understanding the P-field is ***globally declared internally*** in the program as follows:

#globdef *Kerf* *P1300*

Syntax: ***G41 R = Kerf E0***

3.7.4 Approach Contour (G0/G1)

The approach contour starts the actual motion of the axis and use the rapid traverse command ***G0*** or Linear command ***G1*** to position the axis to the piercing point. During this motion, the head is positioned along with the tool offset value (kerf width) The approach point can be reached with single statement by simultaneous interpolation of the axis, there may be a case where it may take more than one statement is also possible.

Syntax: ***G0/G1 X0 Y0***

- ✓ ***Note: The approach contour should be always followed by M14 command for the 'Frog Jump' function of head.***

3.7.5 Laser ON Function (M14)

The Laser ON function is called via M-command "**M14**". The call of M14 will activate the following functions:

- ✓ Switch on the Height regulation control
- ✓ Switch on the Piercing Gas solenoid & pressure valve
- ✓ Move the Z-axis to Piercing Position
- ✓ Switch on the Laser beam for Piercing
- ✓ Switch to the Cutting Gas parameters

- ✓ Move the Z-axis to Cutting Position
- ✓ Set focal position
- ✓ Set Beam diameter
- ✓ Set Laser power
- ✓ Switch on the Laser beam for Cutting

Syntax: ***M14***

3.7.6 Process Contour (G1, G2, G3…,)

The complete set of contour statements between **M14 & M15** constitutes the process contour, where the actual laser technology take place. It is possible to identify the Acc/Dec phase, Corner, End of approach etc., for the complete process of contour.

Also, before the start of contour statements, it is possible to define the type of process as Cutting/Marking for DIN program display in HMI as dashed lines. ***Please refer the Chapter 2.6 for more details.***

Syntax: ***G1 X124.5 Y35.5***

G3 X115.5 Y35.5 I-4.5 J0

3.7.7 Laser OFF Function (M15)

The Laser OFF function is called via M-command "**M15**". The call of M15 will activate the following functions:

- ✓ Switch Off the Laser beam
- ✓ Switch Off the Gas
- ✓ Retract the Z-axis to defined position

No other M-function must be set before a M15. The M15 must always be set after a positioning block/contour block.

3.7.8 Cancel Kerf Compensation

The activated Kerf compensation at the start of contour need to be cancelled at the end in order to position the head for the next contour without compensation.

Syntax: ***G40 E1***

3.8 Program End (G99)

The preparatory function ***G99*** must be the last command followed by N65535 block number for the call of Outer Bound check in the Laser technology program. No other address must be programmed in a block that contains the preparatory function G99.

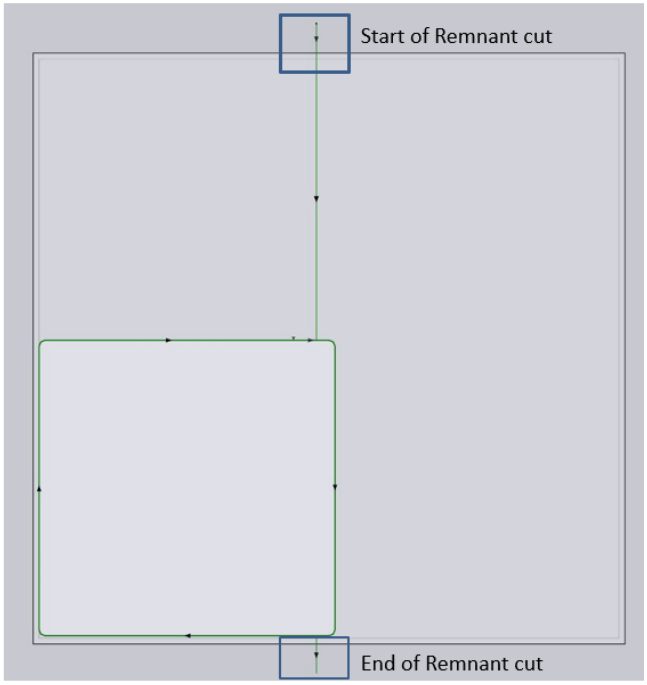
Syntax: ***G99***
N65535
CallBoundPrg
G99

4 Remnant Cut

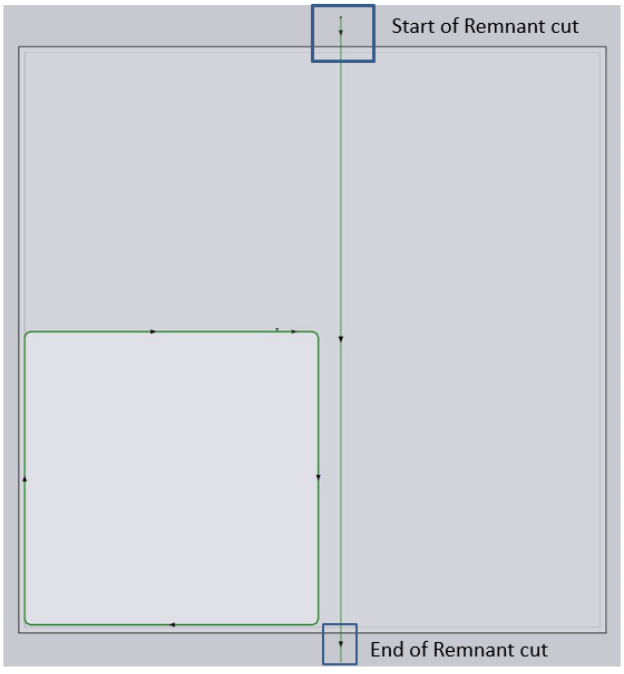
The remaining portion of a nested sheet can be cut and removed for easy handling of the jobs. In order to remove the remnant part, the cutting need to be started from outside the sheet and end beyond the sheet to make sure the part is completely removed from the jobs.

For easy understanding, the remnant cut can be differentiated as two parts as follows:

A. Start Remnant Cut
B. End Remnant Cut



In a nesting job, there may be need for start of remnant cut (or) end of remnant cut (or) both depends on the availability of the remnant sheet.



4.1 Start Remnant Cut

In Start Remnant cut, the cutting will be started from outside sheet and below are the procedures to be followed:

i. Set the "Distance Regulation Control" as ***'2'*** in cutting method!
ii. Set the "Remnant cut" bit in cutting method! (2nd Decimal = 2)
iii. The following M14 command will not switch on the beam but position the head inside the sheet and gas is ON.
iv. After the head is positioned, the negative motion of Z-axis is stopped, but allowed in positive direction (Distance Regulation = 2).
v. Now move the head outside the sheet
vi. Switch On the beam by ***"M1014"*** command.
vii. Once the cutting enters into the sheet and after certain distance, switch on the "Distance Regulation On" by ***"M1012"*** command.

Sample Code:

G0 X478.512 Y990	Position the head inside the sheet
PM=0.000	Piercing method should be 0
CM=102.120	Distance regulation = 2 1st Decimal = 1 => Lead-in cut = Active (Optional) 2nd Decimal = 2 => Remnant cut = Active
EM=1.000	Normal End method
ZRH=40	Z – retract height = 40
Update_Param	Update the parameters
G61	
Lead_In=10	Lead in distance = 10mm (Optional)
M14	Position the head to cutting height and gas is ON
G01 X478.512 Y1005	Head is locked and move the head outside the sheet edge
M1014	Switch on the Laser beam with lead in parameter
G01 X478.512 Y995	Lead In distance = 10mm (Optional)
G01 X478.512 Y990	Switch to contour parameter
M1012	Switch ON the Distance Regulation
G01 X478.512 Y514	Continue the cutting till the end
M15	
G40 E1	

4.2 End Remnant Cut

In End Remnant cut, the head need to travel beyond the sheet edge to complete the cutting such that the part can be removed easily. Hence, it is required to lock the cutting head motion before certain distance reaching the sheet edge, such that the head is not driven down in absence of sheet below.

i. Split the last motion command into 2, such that 1 command is within sheet and the other moves beyond the edge of the sheet.
ii. Insert the ***"M1011"*** command between the above 2 motion commands, such that after the first command, the head will be locked and moved outside the sheet with the second command.

Sample Code:

G0 X478.512 Y11	Position the head with some distance from the job
PM=3.000	Start with the Piercing
CM=100.000	Normal cutting method
EM=1.000	Normal End method
ZRH=40	Z – retract height = 40
Update_Param	Update the parameters
G61	
Lead_In=0	
M14	Start piercing and then cutting
G01 X478.512 Y14	Move towards the job to clear the distance for piercing
G01 X478.512 Y10	Move away from the Job
M1011	Distance Regulation OFF
G01 X478.512 Y-5	Move away from the sheet edge
M15	
G40 E1	

Note: When both type of remnant cuts are needed, use the PM, CM & EM from the Start Remnant cut and just use the M1011 at the end of remnant cut.

5 Fly Cut/Stitch Cut

Fly Cut is cutting without piercing with constant speed. The piercing is done on the fly and the advantage is that the cutting times of thin sheet metal can noticeably be reduced.

Fly cut is a time-sensitive function and works with a so-called quick output to activate / deactivate the laser. The quick output is written in the DIN program and has a predefined address in the process of the controller. Fly Cut uses the first output of the particular output module as default.

Furthermore, the cutting results can be improved distinctly by the delayed activation / deactivation of the laser. This can be achieved through the call of the output signal handler (G222 V7 I=P1302 J=P1303 E0, via. 9400.zyk) and the definition of the delay time in the technology table (LPG ON delay, LPG OFF delay). The Fly Cut need to be activated in the "CM" – cutting method, refer above.

Syntax: ***Q0=1 / Q0=0*** ***(Laser active/deactive)***

Refer Chapter 7, for detailed example of Fly cut program.

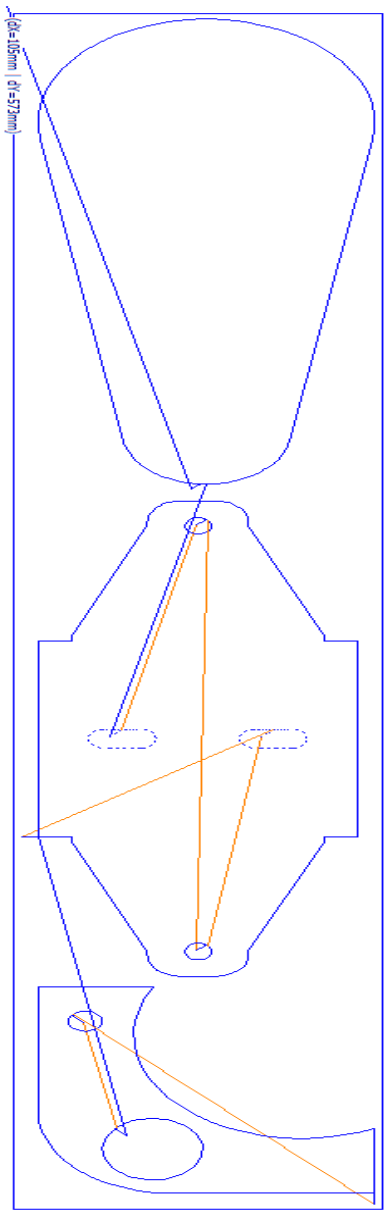
6 Only Piercing in the Contour

If in the contour there is only piercing, then there should be a dummy movement of axis to wait for pierce to complete. Also, the Cutter compensation should be cancelled (No G41/G42).

```
N4
BlockNo=4
PM=20.000 CM=000.000
EM=1.000 ZRH=20
Update_Param
G61
Lead_In=0
G40
G0 X57.018 Y461.5
M14
G1 X0.001 I2 (Dummy movement)
M15
G40 E1
```

7 Sample Program with Multiple Parts

The below program is designed with 3 different parts, with certain contours having marking definitions etc., for the reference:



```
%1 (PP_Sample_Pgm.DIN)
Sheet_Size_X = 120
Sheet_Size_Y = 600
Job_Size_X = 105
Job_Size_Y = 573
X_Limit_Minus = 10
X_Limit_Plus = 115
Y_Limit_Minus = 10
Y_Limit_Plus = 583
G90
M15
CheckBoundPrg
```

```
G253 F="TT:MS_1mm"
H0
```

```
G20 X1
```

```
N1
BlockNo=1
```

```
M01 (start part 1)
```

```
PM=20.000 CM=100.000
EM=1.000 ZRH=20
Update_Param
```

```
G61
Lead_In=4.999
G41 R=KERF E0
G0 X55.798 Y237.995
M14
G3 X60.005 Y235.697 I4.207 J2.702
G2 X84.655 Y214.863 I0 J-25
G1 X109.306 Y69.03
G2 X10.704 Y69.03 I-49.301 J-8.333
G1 X35.355 Y214.863
G2 X60.005 Y235.697 I24.65 J-4.167
M15
G40 E1
```

```
G20 X2
```

```
N2
BlockNo=2
```

```
M01 (start part 2)
```

```
PM=20.000 CM=300.000
EM=1.000 ZRH=20
Update_Param
```

```
G61
Lead_In=5.0
G41 R=KERF E0
G0 X31.469 Y358.031
M14
{LB,K0} (Dash line for Marking in HMI)
G1 X35.005 Y354.495
G1 X40.505 Y354.495
G3 X40.505 Y363.495 I0 J4.5
G1 X29.505 Y363.495
G3 X29.505 Y354.495 I0 J-4.5
G1 X35.005 Y354.495
```

```
{LE} (End Dash line)
M15
G40 E1
```

```
G20 X3
```

```
N3
BlockNo=3
```

```
PM=20.000 CM=100.000
EM=1.000 ZRH=20
Update_Param
```

```
G61
Lead_In=4.374
G41 R=KERF E0
G0 X57.018 Y255.5
M14
G1 X59.395 Y253.163
G3 X60.333 Y253.167 I0.467 J0.475
G3 I-2.828 J2.828
M15
G40 E1
```

```
G20 X4
```

```
N4
BlockNo=4
```

```
PM=20.000 CM=100.000
EM=1.000 ZRH=20
Update_Param
```

```
G61
Lead_In=4.374
G41 R=KERF E0
G0 X57.018 Y461.5
M14
G1 X59.395 Y459.163
G3 X60.333 Y459.167 I0.467 J0.475
G3 I-2.828 J2.828
M15
G40 E1
```

```
G20 X5
```

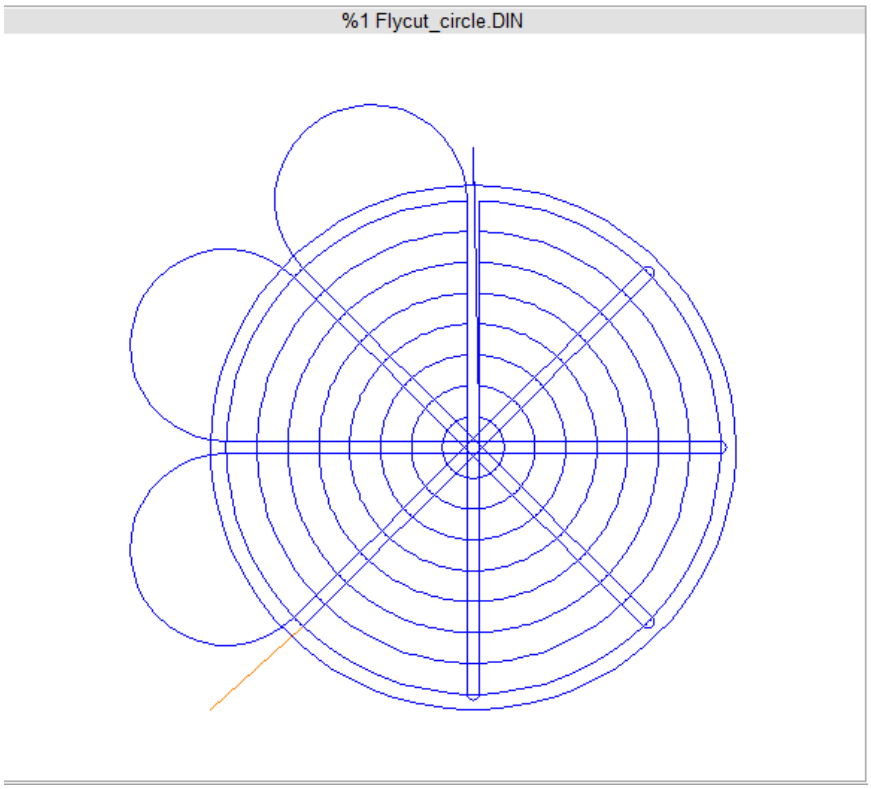
```
N5
BlockNo=5
```

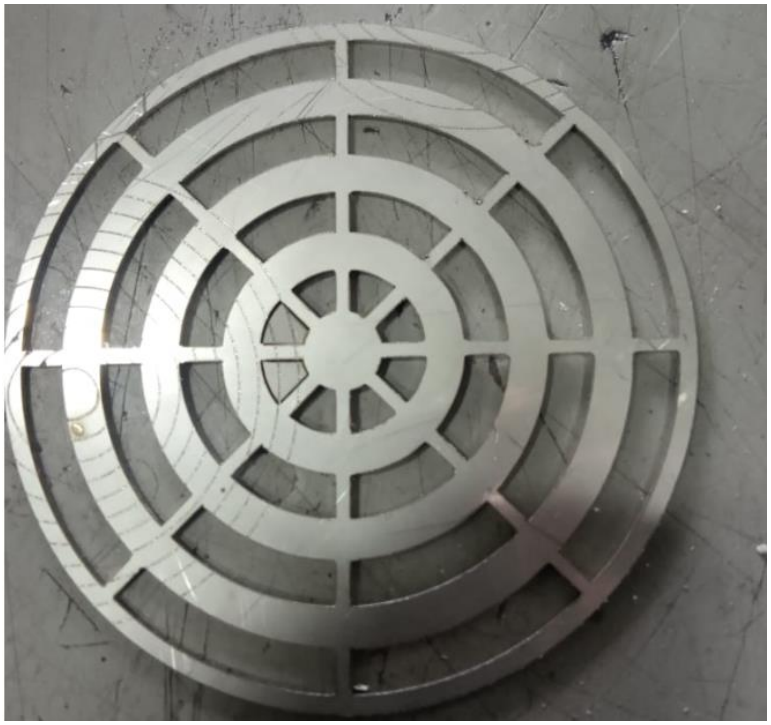
```
PM=20.000 CM=300.000
EM=1.000 ZRH=20
Update_Param
```

```
G61
Lead_In=5.0
G41 R=KERF E0
G0 X76.469 Y358.031
M14
{LB,K0} (Dash line for Marking in HMI)
G1 X80.005 Y354.495
G1 X85.505 Y354.495
G3 X85.505 Y363.495 I-0.133 J4.5
G1 X74.505 Y363.495
G3 X74.505 Y354.495 I0 J-4.5
G1 X80.005 Y354.495
{LE} (End Dash line)
M15
G40 E1
```

```
G20 X6
N6
BlockNo=6
PM=20.000 CM=100.000
EM=1.200 ZRH=20
Update_Param
G61
Lead_In=5.0
G41 R=KERF E0
G0 X5.005 Y406.495
M14
G1 X10.005 Y406.495
G1 X20.005 Y406.495
G1 X20.005 Y408.995
G1 X42.505 Y461.995
G1 X42.505 Y463.995
G2 X52.505 Y473.995 I10 J0
G1 X62.505 Y473.995
G2 X72.505 Y463.995 I0 J-10
G1 X72.505 Y461.995
G1 X95.005 Y408.995
G1 X95.005 Y406.495
G1 X105.005 Y406.495
G1 X105.005 Y311.495
G1 X95.005 Y311.495
G1 X95.005 Y308.995
G1 X72.505 Y255.995
G1 X72.505 Y253.995
G2 X62.505 Y243.995 I-10 J0
G1 X52.505 Y243.995
G2 X42.505 Y253.995 I0 J10
G1 X42.505 Y255.995
G1 X20.005 Y308.995
G1 X20.005 Y311.495
G1 X10.005 Y311.495
G1 X10.005 Y406.495
M15
G40 E1
G20 X7
N7
BlockNo=7
M01 (start part 3)
PM=20.000 CM=100.000
EM=1.000 ZRH=20
Update_Param
G61
Lead_In=5.47
G41 R=KERF E0
G0 X36.421 Y551.137
M14
G1 X33.499 Y548.166
G3 X33.504 Y546.992 I0.594 J-0.584
G3 I10.607 J10.607
M15
G40 E1
G20 X8
N8
BlockNo=8
PM=20.000 CM=100.000
EM=1.000 ZRH=20
Update_Param
G61
Lead_In=5.47
G41 R=KERF E0
G0 X23.48 Y496.294
M14
G1 X20.558 Y493.324
G3 X20.563 Y492.15 I0.594 J-0.584
G3 I3.536 J3.536
M15
G40 E1
G20 X9
N9
BlockNo=9
PM=20.000 CM=100.000
EM=1.000 ZRH=20
Update_Param
G61
Lead_In=5.0
G41 R=KERF E0
G0 X110.005 Y583.995
M14
G1 X110.005 Y578.995
G1 X110.005 Y547.56
G3 X44.352 Y478.995 I-21.472 J-45.155
G1 X10.005 Y478.995
G1 X10.005 Y538.995
G2 X50.005 Y578.995 I40 J0
G1 X110.005 Y578.995
M15
G40 E1
G99 (program end)
N65535
CallBoundPrg
G99
```

8 Fly Cut Sample Program:





```
%1 (FlyCut_Circle.DIN)
Sheet_Size_X = 120
Sheet_Size_Y = 120
Job_Size_X = 85
Job_Size_Y = 85
X_Limit_Minus = 10
X_Limit_Plus = 130
Y_Limit_Minus = 10
Y_Limit_Plus = 130
G90
M15
CheckBoundPrg
```

```
G253 F="TT:SS_0.8mm" H0
```

```
G20 X1
```

```
N1
BlockNo=1
```

```
M01 (start part 1)
```

```
PM=0.000 CM=100.400
EM=1.000 ZRH=30
Update_Param
```

```
G61
Lead_In=0
G41 R0 E0
G00 X13.517Y14.932
M14
Q0=1
G01 X17.054 Y18.468
Q0=0
G01 X20.591 Y22.006
Q0=1
G01 X24.129 Y25.544
Q0=0
G01 X27.668 Y29.083
Q0=1
G01 X31.210 Y32.624
Q0=0
G01 X34.757 Y36.171
Q0=1
G01 X38.329 Y39.743
Q0=0
G01 X45.257 Y46.671
Q0=1
G01 X48.829 Y50.243
Q0=0
G01 X52.376 Y53.790
Q0=1
G01 X55.917 Y57.332
Q0=0
G01 X59.456 Y60.871
Q0=1
G01 X62.994 Y64.409
Q0=0
G01 X66.532 Y67.946
Q0=1
G01 X70.068 Y71.483
Q0=0
G02 X71.483 Y70.068 I0.707 J-0.707
Q0=1
G01 X67.946 Y66.532
Q0=0
G01 X64.409 Y62.994
Q0=1
G01 X60.871 Y59.456
Q0=0
G01 X57.332 Y55.917
Q0=1
G01 X53.790 Y52.376
Q0=0
G01 X50.243 Y48.829
Q0=1
G01 X46.671 Y45.257
Q0=0
G01 X39.743 Y38.329
Q0=1
G01 X36.171 Y34.757
Q0=0
G01 X32.624 Y31.210
Q0=1
G01 X29.083 Y27.668
Q0=0
G01 X25.544 Y24.129
Q0=1
G01 X22.006 Y20.591
Q0=0
G01 X18.468 Y17.054
Q0=1
G01 X14.932 Y13.517
Q0=0
G03 X41.500 Y2.513 I11.005 J-11.005
Q0=1
G01 Y7.514
Q0=0
G01 Y12.517
Q0=1
G01 Y17.520
Q0=0
G01 Y22.525
Q0=1
G01 Y27.533
Q0=0
G01 Y32.550
Q0=1
G01 Y37.601
Q0=0
G01 Y47.399
Q0=1
G01 Y52.450
Q0=0
G01 Y57.467
Q0=1
```

```
G01 Y62.475
Q0=0
G01 Y67.480
Q0=1
G01 Y72.483
Q0=0
G01 Y77.486
Q0=1
G01 Y82.487
Q0=0
G02 X43.500 I1.000 J0.000
Q0=1
G01 Y77.486
Q0=0
G01 Y72.483
Q0=1
G01 Y67.480
Q0=0
G01 Y62.475
Q0=1
G01 Y57.467
Q0=0
G01 Y52.450
Q0=1
G01 Y47.399
Q0=0
G01 Y37.601
Q0=1
G01 Y32.550
Q0=0
G01 Y27.533
Q0=1
G01 Y22.525
Q0=0
G01 Y17.520
Q0=1
G01 Y12.517
Q0=0
G01 Y7.514
Q0=1
G01 Y2.513
Q0=0
G03 X70.068 Y13.517 I15.563 J0.000
Q0=1
G01 X66.532 Y17.054
Q0=0
G01 X62.994 Y20.591
Q0=1
G01 X59.456 Y24.129
Q0=0
G01 X55.917 Y27.668
Q0=1
G01 X52.376 Y31.210
Q0=0
G01 X48.829 Y34.757
Q0=1
G01 X45.257 Y38.329
Q0=0
G01 X38.329 Y45.257
Q0=1
G01 X34.757 Y48.829
Q0=0
G01 X31.210 Y52.376
Q0=1
G01 X27.668 Y55.917
Q0=0
G01 X24.129 Y59.456
Q0=1
G01 X20.591 Y62.994
Q0=0
G01 X17.054 Y66.532
Q0=1
G01 X13.517 Y70.068
Q0=0
G02 X14.932 Y71.483 I0.707 J0.707
Q0=1
G01 X18.468 Y67.946
Q0=0
G01 X22.006 Y64.409
Q0=1
G01 X25.544 Y60.871
Q0=0
G01 X29.083 Y57.332
Q0=1
G01 X32.624 Y53.790
Q0=0
G01 X36.171 Y50.243
Q0=1
G01 X39.743 Y46.671
Q0=0
G01 X46.671 Y39.743
Q0=1
G01 X50.243 Y36.171
Q0=0
G01 X53.790 Y32.624
Q0=1
G01 X57.332 Y29.083
Q0=0
G01 X60.871 Y25.544
Q0=1
G01 X64.409 Y22.006
Q0=0
G01 X67.946 Y18.468
Q0=1
G01 X71.483 Y14.932
Q0=0
G03 X82.487 Y41.500 I11.005 J11.005
Q0=1
G01 X77.486
Q0=0
G01 X72.483
Q0=1
G01 X67.480
Q0=0
```

```
G01 X62.475
Q0=1
G01 X57.467
Q0=0
G01 X52.450
Q0=1
G01 X47.399
Q0=0
G01 X37.601
Q0=1
G01 X32.550
Q0=0
G01 X27.533
Q0=1
G01 X22.525
Q0=0
G01 X17.520
Q0=1
G01 X12.517
Q0=0
G01 X7.514
Q0=1
G01 X2.513
Q0=0
G02 Y43.500 I0.000 J1.000
Q0=1
G01 X7.514
Q0=0
G01 X12.517
Q0=1
G01 X17.520
Q0=0
G01 X22.525
Q0=1
G01 X27.533
Q0=0
G01 X32.550
Q0=1
G01 X37.601
Q0=0
G01 X47.399
Q0=1
G01 X52.450
Q0=0
G01 X57.467
Q0=1
G01 X62.475
Q0=0
G01 X67.480
Q0=1
G01 X72.483
Q0=0
G01 X77.486
Q0=1
G01 X82.487
G03 X71.483 Y70.068 I-39.987 J-1.000
Q0=0
```

```
G03 X70.068 Y71.483 I-28.983 J-27.568
Q0=1
G03 X43.500 Y82.487 I-27.568 J-28.983
Q0=0
G03 X41.500 I-1.000 J-39.987
Q0=1
G03 X14.932 Y71.483 I1.000 J-39.987
Q0=0
G03 X13.517 Y70.068 I27.568 J-28.983
Q0=1
G03 X2.513 Y43.500 I28.983 J-27.568
Q0=0
G03 Y41.500 I39.987 J-1.000
Q0=1
G03 X13.517 Y14.932 I39.987 J1.000
Q0=0
G03 X14.932 Y13.517 I28.983 J27.568
Q0=1
G03 X41.500 Y2.513 I27.568 J28.983
Q0=0
G03 X43.500 I1.000 J39.987
Q0=1
G03 X70.068 Y13.517 I-1.000 J39.987
Q0=0
G03 X71.483 Y14.932 I-27.568 J28.983
Q0=1
G03 X82.487 Y41.500 I-28.983 J27.568
Q0=0
G01 X77.486
Q0=1
G02 X67.946 Y18.468 I-34.986 J1.000
Q0=0
G02 X66.532 Y17.054 I-25.446 J24.032
Q0=1
G02 X43.500 Y7.514 I-24.032 J25.446
Q0=0
G02 X41.500 I-1.000 J34.986
Q0=1
G02 X18.468 Y17.054 I1.000 J34.986
Q0=0
G02 X17.054 Y18.468 I24.032 J25.446
Q0=1
G02 X7.514 Y41.500 I25.446 J24.032
Q0=0
G02 Y43.500 I34.986 J1.000
Q0=1
G02 X17.054 Y66.532 I34.986 J-1.000
Q0=0
G02 X18.468 Y67.946 I25.446 J-24.032
Q0=1
G02 X41.500 Y77.486 I24.032 J-25.446
Q0=0
G02 X43.500 I1.000 J-34.986
Q0=1
G02 X66.532 Y67.946 I-1.000 J-34.986
Q0=0
G02 X67.946 Y66.532 I-24.032 J-25.446
```

```
Q0=1
G02 X77.486 Y43.500 I-25.446 J-24.032
Q0=0
G01 X72.483
Q0=1
G03 X64.409 Y62.994 I-29.983 J-1.000
Q0=0
G03 X62.994 Y64.409 I-21.909 J-20.494
Q0=1
G03 X43.500 Y72.483 I-20.494 J-21.909
Q0=0
G03 X41.500 I-1.000 J-29.983
Q0=1
G03 X22.006 Y64.409 I1.000 J-29.983
Q0=0
G03 X20.591 Y62.994 I20.494 J-21.909
Q0=1
G03 X12.517 Y43.500 I21.909 J-20.494
Q0=0
G03 Y41.500 I29.983 J-1.000
Q0=1
G03 X20.591 Y22.006 I29.983 J1.000
Q0=0
G03 X22.006 Y20.591 I21.909 J20.494
Q0=1
G03 X41.500 Y12.517 I20.494 J21.909
Q0=0
G03 X43.500 I1.000 J29.983
Q0=1
G03 X62.994 Y20.591 I-1.000 J29.983
Q0=0
G03 X64.409 Y22.006 I-20.494 J21.909
Q0=1
G03 X72.483 Y41.500 I-21.909 J20.494
Q0=0
G01 X67.480
Q0=1
G02 X60.871 Y25.544 I-24.980 J1.000
Q0=0
G02 X59.456 Y24.129 I-18.371 J16.956
Q0=1
G02 X43.500 Y17.520 I-16.956 J18.371
Q0=0
G02 X41.500 I-1.000 J24.980
Q0=1
G02 X25.544 Y24.129 I1.000 J24.980
Q0=0
G02 X24.129 Y25.544 I16.956 J18.371
Q0=1
G02 X17.520 Y41.500 I18.371 J16.956
Q0=0
G02 Y43.500 I24.980 J1.000
Q0=1
G02 X24.129 Y59.456 I24.980 J-1.000
Q0=0
G02 X25.544 Y60.871 I18.371 J-16.956
Q0=1
G02 X41.500 Y67.480 I16.956 J-18.371
Q0=0
G02 X43.500 I1.000 J-24.980
Q0=1
G02 X59.456 Y60.871 I-1.000 J-24.980
Q0=0
G02 X60.871 Y59.456 I-16.956 J-18.371
Q0=1
G02 X67.480 Y43.500 I-18.371 J-16.956
Q0=0
G01 X62.475
Q0=1
G03 X57.332 Y55.917 I-19.975 J-1.000
Q0=0
G03 X55.917 Y57.332 I-14.832 J-13.417
Q0=1
G03 X43.500 Y62.475 I-13.417 J-14.832
Q0=0
G03 X41.500 I-1.000 J-19.975
Q0=1
G03 X29.083 Y57.332 I1.000 J-19.975
Q0=0
G03 X27.668 Y55.917 I13.417 J-14.832
Q0=1
G03 X22.525 Y43.500 I14.832 J-13.417
Q0=0
G03 Y41.500 I19.975 J-1.000
Q0=1
G03 X27.668 Y29.083 I19.975 J1.000
Q0=0
G03 X29.083 Y27.668 I14.832 J13.417
Q0=1
G03 X41.500 Y22.525 I13.417 J14.832
Q0=0
G03 X43.500 I1.000 J19.975
Q0=1
G03 X55.917 Y27.668 I-1.000 J19.975
Q0=0
G03 X57.332 Y29.083 I-13.417 J14.832
Q0=1
G03 X62.475 Y41.500 I-14.832 J13.417
Q0=0
G01 X57.467
Q0=1
G02 X53.790 Y32.624 I-14.967 J1.000
Q0=0
G02 X52.376 Y31.210 I-11.290 J9.876
Q0=1
G02 X43.500 Y27.533 I-9.876 J11.290
Q0=0
G02 X41.500 I-1.000 J14.967
Q0=1
G02 X32.624 Y31.210 I1.000 J14.967
Q0=0
G02 X31.210 Y32.624 I9.876 J11.290
Q0=1
G02 X27.533 Y41.500 I11.290 J9.876
```

```
Q0=0
G02 Y43.500 I14.967 J1.000
Q0=1
G02 X31.210 Y52.376 I14.967 J-1.000
Q0=0
G02 X32.624 Y53.790 I11.290 J-9.876
Q0=1
G02 X41.500 Y57.467 I9.876 J-11.290
Q0=0
G02 X43.500 I1.000 J-14.967
Q0=1
G02 X52.376 Y53.790 I-1.000 J-14.967
Q0=0
G02 X53.790 Y52.376 I-9.876 J-11.290
Q0=1
G02 X57.467 Y43.500 I-11.290 J-9.876
Q0=0
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CallBoundPrg
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