# INTERNATIONAL STANDARD 1056

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# Numerical control of machines — Punched tape block formats — Coding of preparatory functions G and miscellaneous functions M

*Commande numérique des machines — Formats de blocs des bandes perforées — Codage des fonctions préparatoires G et des fonctions auxiliaires M*

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## FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 1056 was drawn up by Technical Committee ISO/TC 97, *Computers and information processing,* and circulated to the Member Bodies in January 1974.

It has been approved by the Member Bodies of the following countries:

| | | |
|---|---|---|
| Australia | Japan | Thailand |
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| Germany | South Africa, Rep. of | U.S.S.R. |
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No Member Body expressed disapproval of the document.

This International Standard cancels and replaces ISO Recommendation R 1056-1969, of which it constitutes a technical revision.





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# Numerical control of machines — Punched tape block formats — Coding of preparatory functions G and miscellaneous functions M



## 0 INTRODUCTION

The International Standards

ISO 1057, *Numerical control of machines — Interchangeable punched tape variable block format for positioning and straight-cut machining,*

ISO 1058, *Numerical control of machines — Punched tape variable block format for positioning and straight-cut machining,*

ISO 1059, *Numerical control of machines — Punched tape fixed block format for positioning and straight-cut machining,* and

ISO 2539, *Numerical control of machines — Punched tape variable block format for contouring and contouring/positioning machining,*

specify the block formats of punched tapes used for the numerical control of machines (addresses, blocks, words, etc.). However, for the "preparatory function" G and "miscellaneous function" M words, it was found better to establish a separate International Standard the content of which may be used for each type of formats.

## 1 SCOPE AND FIELD OF APPLICATION

This International Standard defines the coding of "preparatory functions" G and "miscellaneous functions" M used for the numerical control of machines, by means of a two-digit code.

## 2 CODING OF PREPARATORY FUNCTIONS G

### 2.1 Table

| Code | Function retained until cancelled or superseded by subsequent command of the same letter designation | Function affects only the block within which it appears | Function |
|---|---|---|---|
| G00 | a | | Point-to-Point, Positioning |
| G01 | a | | Linear Interpolation |
| G02 | a | | Circular Interpolation Arc CW |
| G03 | a | | Circular Interpolation Arc CCW |
| G04 | | X | Dwell |
| G05 | * | * | Unassigned[1)] |
| G06 | a | | Parabolic Interpolation |
| G07 | * | • | Unassigned |
| G08 | | X | Acceleration |
| G09 | | X | Deceleration |
| G10 | * | * | Unassigned[2)] |
| G11 | * | * | Unassigned[2)] |
| G12 | * | * | Unassigned[3)] |
| G13 to G16 | * | * | Unassigned[4)] |
| G17 | c | | XY Plane Selection |
| G18 | c | | ZX Plane Selection |
| G19 | c | | YZ Plane Selection |
| G20 | * | * | Unassigned[2)] |
| G21 | * | * | Unassigned[2)] |
| G22 | * | * | Unassigned[5)] |
| G23 | * | * | Unassigned[5)] |
| G24 | * | * | Unassigned |
| G25 to G29 | * | * | Permanently Unassigned |
| G30 | * | * | Unassigned[2)] |
| G31 | * | * | Unassigned[2)] |
| G32 | * | * | Unassigned |
| G33 | a | | Thread Cutting, Constant Lead |
| G34 | a | | Thread Cutting, Increasing Lead |
| G35 | a | | Thread Cutting, Decreasing Lead |
| G36 to G39 | * | * | Permanently Unassigned |

1) Previously "Hold".

2) Previously "Interpolation — long and short dimensions".

3) Previously "3D-Interpolation".

4) Previously "Axis selection".

5) Previously "Coupled motion — positive and negative".

* The choice of a particular case must be designated in the Format Specification.

| Code | Function retained until cancelled or superseded by subsequent command of the same letter designation | Function affects only the block within which it appears | Function |
|---|---|---|---|
| G40 | d | | Cutter Compensation/Tool Offset Cancel |
| G41 | d | | Cutter Compensation – Left |
| G42 | d | | Cutter Compensation – Right |
| G43 | *(d) | * | Tool Offset Positive[1) 2)] |
| G44 | *(d) | * | Tool Offset Negative[1) 2)] |
| G45 | *(d) | * | Tool Offset +/+[1) 2) 3)] |
| G46 | *(d) | * | Tool Offset +/–[1) 2) 3)] |
| G47 | *(d) | * | Tool Offset –/–[1) 2) 3)] |
| G48 | *(d) | * | Tool Offset –/+[1) 2) 3)] |
| G49 | *(d) | * | Tool Offset 0/+[1) 2) 3)] |
| G50 | *(d) | * | Tool Offset 0/–[1) 2) 3)] |
| G51 | *(d) | * | Tool Offset +/0[1) 2) 3)] |
| G52 | *(d) | * | Tool Offset –/0[1) 2) 3)] |
| G53 | f | | Linear Shift Cancel[4)] |
| G54 | f | | Linear Shift X[4)] |
| G55 | f | | Linear Shift Y[4)] |
| G56 | f | | Linear Shift Z[4)] |
| G57 | f | | Linear Shift XY[4)] |
| G58 | f | | Linear Shift XZ[4)] |
| G59 | f | | Linear Shift YZ[4)] |
| G60 | h | | Positioning Exact 1[4)] (Fine) |
| G61 | h | | Positioning Exact 2[4)] (Medium) |
| G62 | h | | Positioning Fast[4)] (Coarse) |
| G63 | | X | Tapping[4)] |
| G64 | * | * | Unassigned[5)] |
| G65 to G67 | * | * | Unassigned[6)] |
| G68 | *(d) | X | Tool Offset Inside Corner[2)] |
| G69 | *(d) | X | Tool Offset Outside Corner[2)] |
| G70 to G79 | * | * | Unassigned |
| G80 | e | | Fixed Cycle Cancel |
| G81 to G89 | e | | Fixed Cycle |
| G90 | j | | Absolute Dimension |
| G91 | j | | Incremental Dimension |
| G92 | | X | Preload Registers |
| G93 | k | | Inverse Time, Feed Rate |
| G94 | k | | Feed per Minute |
| G95 | k | | Feed per Spindle Revolution |
| G96 | l | | Constant Surface Speed |
| G97 | l | | Revolutions per Minute (Spindle) |
| G98 to G99 | * | * | Unassigned |

1) If cutter compensation for straight-cut controls is not provided, G43 to G52 are unassigned and are available for other uses.

2) Letter (d) between brackets in the left-hand column means that if the option used is the one of the left-hand column, the cancel or replacement function shall be one of those designated by the letter d without brackets. The cancel or replacement function may also be one of those designated by the letter (d) between brackets, if the option used for that replacement function is the one of the left-hand column.

3) Functions G45 to G52 may apply to any two different predetermined axes of the machine.

4) If these functions are not provided in the control, they are unassigned and available for other uses.

5) Previously "Change of rate".

6) Previously "Reserved for positioning only".

* The choice of a particular case must be designated in the Format Specification.

## 2.2 Definitions

Permanently unassigned codes are for individual use and are not intended to be assigned in future revisions of this International Standard.

Unassigned codes are for individual use. However, in future International Standards or future revisions of this International Standard, particular meanings may be allocated to these unassigned preparatory function code numbers.

| | | |
|---|---|---|
| **G00** | **Point-to Point Positioning** | A mode of control in which movement to the programmed point occurs with maximum, e.g. Rapid, feedrate; a feedrate previously programmed is ignored but not cancelled, and the movements in different axes may be unco-ordinated. |
| **G01** | **Linear Interpolation** | A mode of control, used for a uniform slope or straight line motion, that uses the information contained in a block to produce velocities proportional to the distances to be moved in two or more axes simultaneously. |
| | **Circular Interpolation** | A mode of contouring control that uses the information contained in one or two blocks to produce an arc of a circle, the velocities of the axes used to generate the arc being varied by the control. |
| **G02** | **Circular Interpolation Arc CW** | Circular interpolation in which the curvature of the path of the tool with respect to the work-piece is clockwise when the plane of motion is viewed in the negative direction of the axis perpendicular to it. |
| **G03** | **Circular Interpolation Arc CCW** | Circular interpolation in which the curvature of the path of the tool with respect to the work-piece is counter-clockwise when the plane of motion is viewed in the negative direction of the axis perpendicular to it. |
| **G04** | **Dwell** | A timed delay of programmed or established duration, not cyclic or sequential; i.e. not an interlock or hold. |
| **G06** | **Parabolic Interpolation** | A move of contouring control which uses the information contained in one or more blocks to produce an arc of a parabola. The velocities of the axes used to generate this arc are varied by the control. |
| **G08** | **Acceleration** | An automatic velocity increase to programmed rate starting at beginning of movement. |
| **G09** | **Deceleration** | An automatic velocity decrease from programmed rate starting on approach to the programmed point. |
| **G17 to G19** | **Plane Selection** | Used to identify the plane for such functions as Circular Interpolation, Cutter Compensation, and others as required. |
| **G33** | **Thread Cutting, Constant Lead** | Mode selection for machines equipped for thread cutting. |

| | | |
|---|---|---|
| G34 | **Thread Cutting, Increasing Lead** | Mode selection for machines equipped for thread cutting where a constantly increasing lead is desired. |
| G35 | **Thread Cutting, Decreasing Lead** | Mode selection for machines equipped for thread cutting where a constantly decreasing lead is desired. |
| G40 | **Cutter Compensation/Tool Offset Cancel** | Command which will discontinue any cutter compensation (diameter or radius), or tool offset. |
| G41 | **Cutter Compensation — Left** | Cutter on left side of work surface looking from cutter in the direction of relative cutter motion. |
| G42 | **Cutter Compensation — Right** | Cutter on right side of work surface looking from cutter in the direction of relative cutter motion. |
| G43 | **Tool Offset Positive** | Used to indicate that the value of the Tool Offset (pre-set on the control) has to be added to the co-ordinate dimension of the relevant block, or blocks. |
| G44 | **Tool Offset Negative** | Used to indicate that the value of the Tool Offset (pre-set on the control) has to be subtracted from the co-ordinate dimension of the relevant block, or blocks. |
| G45 to G52 | **Tool Offset** | Used to indicate whether the value of the Tool Offset (pre-set on the control) has to be added to or subtracted from the co-ordinate dimension(s) of the relevant block or blocks, or is zero. |
| G54 to G59 | **Linear Shift** | Used to demand Datum Shift by values pre-set on the controls. |
| G60 | **Positioning Exact 1 (Fine)** | Used for positioning within one or two defined tolerance zones. If necessary, a uni-directional approach can be selected. |
| G61 | **Positioning Exact 2 (Medium)** | |
| G62 | **Positioning Fast (Coarse)** | Used to position to an enlarged tolerance zone with the aim of saving time. |
| G63 | **Tapping** | Positioning with stop of spindle, after reaching the position. |
| G68 | **Tool Offset, Inside Corner** | Used to indicate that the value of the tool offset (pre-set on the control) will be added or subtracted to the co-ordinate dimension of the relevant block or blocks according to the shape of the workpiece (inside corner). |
| G69 | **Tool Offset, Outside Corner** | Used to indicate that the value of the tool offset (pre-set on the control) will be added or subtracted to the co-ordinate dimension of the relevant block or blocks according to the shape of the workpiece (outside corner). |
| G80 | **Fixed Cycle Cancel** | Command which will discontinue any fixed cycle. |

**G81 to G89** — **Fixed Cycle***

A pre-set series of operations which direct machine axis movement and/or cause spindle operation to complete such action as boring, drilling, tapping or combinations thereof.

| Fixed Cycle Code | Movement In | At Bottom | | Movement Out to Feed Start | Typical Usage |
|---|---|---|---|---|---|
| | | Dwell | Spindle | | |
| G81 | Feed | – | – | Rapid | Drill Spot Drill |
| G82 | Feed | Yes | – | Rapid | Drill Counterbore |
| G83 | Intermittent | – | – | Rapid | Deep Hole |
| G84 | Forward Spindle Feed | – | Rev. | Feed | Tap |
| G85 | Feed | – | – | Feed | Bore |
| G86 | Start Spindle Feed | – | Stop | Rapid | Bore |
| G87 | Start Spindle Feed | – | Stop | Manual | Bore |
| G88 | Start Spindle Feed | Yes | Stop | Manual | Bore |
| G89 | Feed | Yes | – | Feed | Bore |

**G92** — **Preload Registers**

Used to modify or set axis position registers by the programmed dimension words. No motion occurs.

**G93** — **Inverse Time Feed Rate**

The data following the feed rate address is equal to the reciprocal of the time in minutes to execute the blocks.

**G94** — **Feed per Minute**

The Feed rate units are millimetres per minute or inches per minute.

**G95** — **Feed per Revolution**

The Feed rate units are millimetres (inches) per revolution of the spindle.

**G96** — **Constant Surface Speed**

The spindle speed codes specify the constant surface speed in metres (feet) per minute. The spindle speed is automatically controlled to maintain the programmed value.

**G97** — **Revolutions per Minute**

Cancels G96.



* This command initiates a sequence of events which will be repeated at the appropriate times until cancelled or changed.

## 3 CODING OF MISCELLANEOUS FUNCTIONS M

### 3.1 Table

| Code | Function starts | | Function retained until cancelled or superseded by an appropriate subsequent command | Function affects only the block within which it appears | Function |
|---|---|---|---|---|---|
| | with commanded motion in its block | after completion of commanded motion in its block | | | |
| M00 | | X | | X | Program Stop |
| M01 | | X | | X | Optional (Planned) Stop |
| M02 | | X | | X | End of Program |
| M03 | X | | X | | Spindle CW |
| M04 | X | | X | | Spindle CCW |
| M05 | | X | X | | Spindle OFF |
| M06 | * | * | | X | Tool Change |
| M07 | X | | X | | Coolant No. 2 ON |
| M08 | X | | X | | Coolant No. 1 ON |
| M09 | | X | X | | Coolant OFF |
| M10 | * | * | X | | Clamp |
| M11 | * | * | X | | Unclamp |
| M12 | * | * | * | * | Unassigned |
| M13 | X | | X | | Spindle CW and Coolant ON |
| M14 | X | | X | | Spindle CCW and Coolant ON |
| M15 | X | | | X | Motion + |
| M16 | X | | | X | Motion − |
| M17 to M18 | * | * | * | * | Unassigned |
| M19 | | X | X | | Oriented Spindle Stop |
| M20 to M29 | * | * | * | * | Permanently Unassigned |
| M30 | | X | | X | End of Tape |
| M31 | * | * | | X | Interlock Bypass |
| M32 to M35 | * | * | * | * | Unassigned[1] |
| M36 | X | | X | | Feed Range 1 |
| M37 | X | | X | | Feed Range 2 |
| M38 | X | | X | | Spindle Speed Range 1 |
| M39 | X | | X | | Spindle Speed Range 2 |
| M40 to M45 | * | * | * | * | Gear Changes if used; otherwise unassigned |
| M46 and M47 | * | * | * | * | Unassigned |

1) Previously "Constant Cutting Speed".

• The choice of a particular case must be designated in the Format Specification.