Revised

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 1056

PUNCHED TAPE BLOCK FORMATS

FOR THE NUMERICAL CONTROL OF MACHINES

CODING OF PREPARATORY FUNCTIONS G

AND MISCELLANEOUS FUNCTIONS M

1st EDITION

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BRIEF HISTORY

The ISO Recommendation R 1056, *Punched tape block formats for the numerical control of machines — Coding of preparatory functions G and miscellaneous functions M*, was drawn up by Technical Committee ISO/TC 97, *Computers and information processing*, the Secretariat of which is held by the United States of America Standards Institute (USASI).

Work on this question led, in 1967, to the adoption of a Draft ISO Recommendation.

In August 1967, this Draft ISO Recommendation (No. 1316) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Israel	Switzerland
Belgium	Netherlands	Turkey
Czechoslovakia	New Zealand	U.A.R.
Denmark	Poland	United Kingdom
France	Portugal	U.S.A.
Germany	Spain	
Iran	Sweden	

Two Member Bodies opposed the approval of the Draft :

Italy
Japan

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in April 1969, to accept it as an ISO RECOMMENDATION.

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INTRODUCTION

The ISO Recommendations

R 1057,   *Interchangeable punched tape variable block format for positioning and straight-cut numerically controlled machines,*

R 1058,   *Punched tape variable block format for positioning and straight-cut numerically controlled machines,*

R 1059,   *Punched tape fixed block format for positioning and straight-cut numerically controlled machines,*

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 ISO Recommendation, the content of which may be used for each type of formats. It is, however, possible that the current study on contouring will require the addition of some functions in the list given by this ISO Recommendation.

1. SCOPE

This ISO Recommendation 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 (Normal Dimensions)
G02	A		Circular Interpolation Arc CW (Normal Dimensions)
G03	A		Circular Interpolation Arc CCW (Normal Dimensions)
G04		X	Dwell
G05		X	Hold
G06	*	*	Unassigned
G07	*	*	Unassigned
G08		X	Acceleration
G09		X	Deceleration
G10	A		Linear Interpolation (Long Dimensions)
G11	A		Linear Interpolation (Short Dimensions)
G12	C		3D-Interpolation
G13 to G16	B		Axis Selection
G17	C		XY Plane Selection
G18	C		ZX Plane Selection
G19	C		YZ Plane Selection
G20	A		Circular Interpolation Arc CW (Long Dimensions)
G21	A		Circular Interpolation Arc CW (Short Dimensions)
G22		X	Coupled Motion Positive [1]
G23		X	Coupled Motion Negative [1]
G24	*	*	Unassigned
G25 to G29	*	*	Permanently Unassigned
G30	A		Circular Interpolation Arc CCW (Long Dimensions)
G31	A		Circular Interpolation Arc CCW (Short Dimensions)
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] If these functions are not provided in the control, they are unassigned and available for other uses.

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

Code	Function retained until cancelled or superseded by sebsequent command of the same letter designation	Function affects only the block within which it appears	Function
G40	D		Cutter Compensation Cancel
G41	D		Cutter Compensation — Left
G42	D		Cutter Compensation — Right
G43	X	X	Cutter Compensation Positive [1]
G44	X	X	Cutter Compensation Negative [1]
G45	X	X	Cutter Compensation +/+ [1] [2]
G46	X	X	Cutter Compensation +/- [1] [2]
G47	X	X	Cutter Compensation -/- [1] [2]
G48	X	X	Cutter Compensation -/+ [1] [2]
G49	X	X	Cutter Compensation 0/+ [1] [2]
G50	X	X	Cutter Compensation 0/- [1] [2]
G51	X	X	Cutter Compensation +/0 [1] [2]
G52	X	X	Cutter Compensation -/0 [1] [2]
G53	F		Linear Shift Cancel [3]
G54	F		Linear Shift X [3]
G55	F		Linear Shift Y [3]
G56	F		Linear Shift Z [3]
G57	F		Linear Shift XY [3]
G58	F		Linear Shift XZ [3]
G59	F		Linear Shift YZ [3]
G60	H		Positioning Exact 1 [3]
G61	H		Positioning Exact 2 [3]
G62	H		Positioning Fast [3]
G63		X	Tapping [3]
G64		X	Change of Rate [3]
G65 to G79	*	*	Reserved for Positioning only
G80	E		Fixed Cycle Cancel
G81	E		Fixed Cycle 1
G82	E		Fixed Cycle 2
G83	E		Fixed Cycle 3
G84	E		Fixed Cycle 4
G85	E		Fixed Cycle 5
G86	E		Fixed Cycle 6
G87	E		Fixed Cycle 7
G88	E		Fixed Cycle 8
G89	E		Fixed Cycle 9
G90 to G99	*	*	Unassigned

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

[2] Functions G45 to G52 may apply to any two different predetermined axes of the machine.

[3] If these functions are not provided in the control, they are unassigned and available for other uses.

* 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 ISO Recommendation.

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

	Arc Clockwise (Arc CW) (See Circular Interpolation)	An arc generated by the coordinated motion of two axes, in which curvature of the path of the tool with respect to the workpiece is clockwise, when viewing the plane of motion in the negative direction of the perpendicular axis.
	Arc Counterclockwise (Arc CCW) (See Circular Interpolation)	An arc generated by the coordinated motion of two axes, in which curvature of the path of the tool with respect to the workpiece is counterclockwise, when viewing the plane of motion in the negative direction of the perpendicular axis.
	Normal Dimensions	Incremental dimensions whose number of digits is specified in the Format Specification. For example, the Format Specification would be + 14 for a normal dimension, i.e. X.XXXX.
	Long Dimensions	Incremental dimensions whose number of digits is one more to the left of the decimal point than for a normal dimension, and the last digit shall be zero, i.e. XX.XXX0 for the example under normal dimensions.
	Short Dimensions	Incremental dimensions whose number of digits is the same as for normal dimensions except the first digit shall be zero, i.e. 0.XXXX for the example under normal dimensions.
	Linear Interpolation G01, G10, G11	A mode of contouring control which uses the information contained in a block to produce velocities proportioned to the distance moved in two or more axes simultaneously.
G01	**Linear Interpolation (Normal Dimensions)**	Used for a slope or straight line mode of operation where the incremental distances are "normal dimensions".*
	Circular Interpolation G02, G20, G21 G03, G30, G31	A mode of contouring control which uses the information contained in a single block to produce an arc of a circle. The velocities of the axes used to generate this arc are varied by the control.*
G02	**Circular Interpolation Arc CW (Normal Dimensions)**	Used for an Arc CW mode of operation where the distances to the arc centre are "normal dimensions".*

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

G03	Circular Interpolation Arc CCW (Normal Dimensions)	Used for an Arc CCW mode of operation where distances to the arc centre are "normal dimensions".*
G04	Dwell	A timed delay of programmed or established duration, not cyclic or sequential; i.e. not an interlock or hold.
G05	Hold	An untimed delay in the programme, terminated by an operator or interlock action.
G08	Acceleration	A controlled velocity increase to programmed rate starting immediately.
G09	Deceleration	A controlled velocity decrease to programmed rate starting immediately.
G10	Linear Interpolation (Long Dimensions)	Used for a slope or straight line mode of operation where the incremental distances are "long dimensions".*
G11	Linear Interpolation (Short Dimensions)	Used for a slope or straight line mode of operation where the incremental distances are "short dimensions".*
G12	3-D Interpolation	Used for cancelling "Plane Selection" when the following motion occurs in 3 axes simultaneously.
G13 to G16	Axis Selection	Used to direct a control to the axis or axes as specified by the format specification as in a system which time-shares the controls.*
G17 to G19	Plane Selection	Used to identify the plane for such functions as Circular Interpolation, Cutter Compensation, and others as required.
G20	Circular Interpolation Arc CW (Long Dimensions)	Used for an Arc CW mode of operation where the distances to the arc centre are "long dimensions".*
G21	Circular Interpolation Arc CW (Short Dimensions)	Used for an Arc CW mode of operation where the distances to the arc centre are "short dimensions".*
G22	Coupled Motion Positive	Used in a straight-cut control. When a motion of one axis under numerical control takes place, motion is also demanded in a different axis coupled to the controlled axis (e.g. by means of gears). The positive sign indicates that the direction of coupled motion is in the same sense as the controlled motion.*
G23	Coupled Motion Negative	Used in straight-cut control. When a motion of one axis under numerical control takes place, motion is also demanded in a different axis coupled to the controlled axis (e.g. by means of gears). The negative sign indicates that the direction of coupled motion is in the opposite sense to the controlled motion.*

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

G30	Circular Interpolation Arc CCW (Long Dimensions)	Used for an Arc CCW mode of operation where distances to the arc centre are "long dimensions".*
G31	Circular Interpolation Arc CCW (Short Dimensions)	Used for an Arc CCW mode of operation where the distances to the arc centre are "short dimensions".*
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.
	Cutter Compensation G40 to G52	Displacement, normal to the cutter path, to adjust for the difference between actual and programmed cutter radii or diameters.*
G40	Cutter Compensation (diameter or radius) Cancel	Command which will discontinue any cutter compensation (diameter or radius).
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	Cutter Compensation Positive	Used in straight-cut controls to indicate that the value of the cutter compensation (pre-set on the control) has to be added to the coordinate dimension of the relevant block.
G44	Cutter Compensation Negative	Used in straight-cut controls to indicate that the value of the cutter compensation (pre-set on the control) has to be subtracted from the coordinate dimension of the relevant block.
G45 to G52	Cutter Compensation	Used in straight-cut control in indicating whether the value of the cutter compensation(s) (pre-set on the control) has to be added to or subtracted from the coordinate dimension(s) of the relevant block, or is zero.
G54 to G59	Linear Shift	Used in straight-cut controls to demand Datum Shift by values pre-set on the controls. The functions are used, for example for :

(1) shifting the working area for pendulum machining;

(2) tool length compensation in drilling or milling (Z axis);

(3) tool position compensation in turning (X, Z axes).

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

| | G60 | Positioning Exact 1 | | Used in straight-cut and positioning systems for positioning within one of two defined tolerance zones. If necessary, a uni-directional approach can be selected. |
| | G61 | Positioning Exact 2 | | |

| | G62 | Positioning Fast | Used in straight-cut and positioning systems to position to an enlarged tolerance zone with the aim of saving time, for example, by switching off the drive at a predetermined point. |

| | G63 | Tapping | Positioning, with stop of spindle, after reaching the position. |

| | G64 | Change of Rate | Used in point-to-point or straight-cut controls, the current feed rate and/or spindle speed, after having reached the programmed position, changes to the higher or lower value programmed in the nearest block, without interrupting the motion. |

| | G80 | Fixed Cycle Cancel | Command which will discontinue any fixed cycle. |

	G81		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.
	to	Fixed Cycle*	
	G89		

| Fixed Cycle | | Movement In | At Bottom | | Movement Out to Feed Start | Typical Usage |
Number	Code		Dwell	Spindle		
1	G81	Feed	—	—	Rapid	Drill Spot Drill
2	G82	Feed	Yes	—	Rapid	Drill Counterbore
3	G83	Intermittent	—	—	Rapid	Deep Hole
4	G84	Forward Spindle Feed	—	Rev.	Feed	Tap
5	G85	Feed	—	—	Feed	Bore
6	G86	Start Spindle Feed	—	Stop	Rapid	Bore
7	G87	Start Spindle Feed	—	Stop	Manual	Bore
8	G88	Start Spindle Feed	Yes	Stop	Manual	Bore
9	G89	Feed	Yes	—	Feed	Bore

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* 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 with commanded motion in its block	Function starts after completion of commanded motion in its block	Function retained until cancelled or superseded by an appropriate subsequent command	Function affects only the block within which it appears	Function
M00		X		X	Programme Stop
M01		X		X	Optional (Planned) Stop
M02		X		X	End of Programme
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–M18	*	*	*	*	Unassigned
M19	*	*		X	Oriented Spindle Stop
M20 to M29	*	*	*	*	Permanently Unassigned
M30		X		X	End of Tape
M31	*	*		X	Interlock By-pass
M32 to M35	X		X		Constant Cutting Speed
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

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