

TITLE		
Specification, Implant Support Software, TCAT		
Document Type: Software specification	Part No: 300071	Revision: 03

1. Description

- 1.1 This document defines the Cutfile Binary Format (CBF). The CBF file provides the toolpath information for cutting implant cavities with the ROBODOC System.
- 1.2 The CBF file can be created from, and converted to, an ASCII format (the CUT file).References

2. Configurations

- 2.1 This document specifies Version 3.0 and 4.0 of the cutfile binary format (CBF).

3. References

- 3.1 Spec, Cutfile ASCII Format (CUT), P/N300072.

4. File Format

- 4.1 This document specifies Version 3.0 and 4.0 of the cutfile binary format (CBF).
- 4.2 **File Header** - The file header is 128 bytes long and has the following fixed record format:
Doc. Attributes: { Version 3.0, 4.0}

Start byte	# bytes	Description
0	4	Special pattern indicating cutting file (e.g. 0x53A1B792)
4	4	Checksum for entire file (starting at byte 8)
8	2	Checksum for rest of header
10	6	Reserved for future checksum usage (Error Correcting Codes)
16	2	Version number for cutfile format (major version, minor version)
18	70	Implant descriptor (part number, manufacturer, type, size): string(70) [Note: part number must be first item specified]
88	34	Configuration descriptor: string(34)
122	2	Number of commands in cutting data section
124	4	Special pattern indicating end of header (complement of start pattern at offset 0)

- 4.3 **Data Records** - The cutting data consists of variable length records, formatted as follows:
Doc. Attributes: { Version 3.0, 4.0}

Start byte	# bytes	Description
0	2	Command sequence number (0 - 65535)
2	1	Command code (see below)
3	1	Backup copy of command code (redundancy)
4	1	Number of bytes used by command arguments (nb)
5	1	Reserved, should be 0
6	2	Checksum of command arguments
8	(nb)	Command arguments (nb = number of bytes specified above)

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5. Supported Commands

5.1 Following is a list of the commands, including the associated hex code, number of bytes and a description of the arguments.

Ver#	CMD CODE	HEX	# bytes	Arguments
3,4	CHECKPOINT	3C	32	Check-point, name: string(16), recovery point: float(3), completion percentage: float
3,4	CUTTER	A3	32	Change cutter, name: string(16), len: float, radius: float, head len: float, 4 bytes reserved
3,4	ORIENT	58	24	Orientation change, tool approach: float(3), reserved: float(3)
3,4	ORIENT5B	59	24	Orientation change, start approach: float(3), end approach: float(3)
3,4	PHASE	21	16	Cutting phase, name: string(16)
3,4	ENABLE_SKIP	22	16	Enable skip to phase, name: string(16)
3,4	STARTSHAPE	C9	6	shape name: string(5), number of (move) cmds: byte
3,4	ENDSHAPE	65	6	same as above (redundancy)
3,4	DECEL_OFF	2B	0	Turn on motion blending (i.e., don't decelerate)
3,4	DECEL_ON	4E	0	Turn off motion blending (i.e., decelerate)
3,4	POINT	33	12	Starting goal point: float(3)
3,4	LINE	B6	24	Straight line motion, start: float(3), end: float(3)
3,4	LINE5B	B7	48	Straight line motion, 5 axis, start_pos: float(3), end_pos: float(3), start_orient: float(3), end_orient: float(3)
3	ARC	94	36	Arc move, start: float(3), middle: float(3), end: float(3)
3	ARC5B	95	60	Arc move, 5 axis, start_pos: float(3), mid_pos: float(3), end_pos: float(3), start_orient: float(3), end_orient: float(3)
3	CIRCLE	7A	40	Circle, start: float(3), center: float(3), normal: float(3), ndegrees: float
3	CIRCLE5B	7B	64	Circle, 5 axis, start: float(3), center: float(3), normal: float(3), ndegrees: float, start_orient: float(3), end_orient: float(3)
3	HELIX	E2	44	Helix, start: float(3), center: float(3), normal: float(3), ndegrees: float, length: float
3	HELIX5B	E3	68	Helix, 5 axis, start: float(3), center: float(3), normal: float(3), ndegrees: float, length: float, start_orient: float(3), end_orient: float(3)
3,4	SPEED	8B	4	Speed: float
3,4	ACCEL	47	8	Acceleration: float, Deceleration: float
3,4	CUTTER_ON	BB	0	Turn cutter on.
3,4	CUTTER_OFF	66	0	Turn cutter off.
3,4	GUIDE	11	32	message: string(32);
3,4	FCPARMS	FC	16	Force control parameters, nom speed: float, max speed: float, min speed: float, max force: float
3,4	VERSION	55	32	Version numbers, cutfile: string(8), format: string(8)
3,4	COMMENT	5A	40	Comment: string(40)

5.2 The symbolic names for "cmd code" shall be defined as an enumerated type in the software, with the corresponding HEX values.

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- 5.3 More detailed information about each command can be obtained in the Cutfile ASCII Format Specification (P/N 300072).

6. Data Integrity Checks

- 6.1 The CBF file provides the following error checking capabilities for the entire system:
- 6.1.1 The first word in the “Implant Descriptor” field in the file header should be the implant part number. The system software can check that this part number is consistent with the implant that was selected by the surgeon (i.e., this ensures that the CBF filename is consistent with the actual implant).
 - 6.1.2 The length and radius of every cutter (specified by the CUTTER command) should agree, within 0.01 millimeters, with the values specified in the robot’s cutter database (e.g., CTR file).
- 6.2 The CBF file provides the following error checking capabilities for the entire file:
- 6.2.1 The checksum of the entire file should match the value specified in the file header.
 - 6.2.2 The number of commands in the file should match the value specified in the file header.
- 6.3 The CBF file provides the following error checking capabilities for the file header:
- 6.3.1 The checksum of the file header should match the specified value.
 - 6.3.2 The first and last fields of the header should match the special values specified in Section 5.1.
- 6.4 The CBF file provides the following redundancy and error checking capabilities for every cutting record:
- 6.4.1 The sequence number should be one greater than the previous sequence number (first record should have sequence number 0).
 - 6.4.2 Both command code fields should be identical.
 - 6.4.3 The number of bytes for the command arguments should be as specified in the table in Section 6.1.
 - 6.4.4 The checksum of the command argument bytes should match the specified value.
 - 6.4.5 The starting point of a motion command (e.g., LINE, ARC, CIRCLE, etc.) should match the ending point of the previous motion command.

7. Backward Compatibility

- 7.1 Backward compatibility is provided by the “Version Number” field in the file header (offset 16). The processing software can read the version number and adjust the parsing logic appropriately.
- 7.2 Change History prior to Initial Release of this document:
- 7.2.1 CBF File Format Version 1.01 was used beginning November 25, 1991.

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7.2.2 CBF File Format Version 2.0 was used beginning December 12, 1995. It introduced the following changes:

- 7.2.2.1 In the file header, the Implant Descriptor field (offset 18) was shortened from 80 to 70 bytes, and the Reserved field that began at offset 98 was renamed the Configuration Descriptor field and changed to begin at offset 88.
- 7.2.2.2 The CHECKPOINT command was modified to include the “recovery point” and “completion percentage” arguments. As a result, the arguments for this command changed from 16 bytes to 32 bytes.
- 7.2.2.3 The CUTTER command was modified to include the “head len” parameter (using 4 bytes that were previously “reserved”). As a result, the number of argument bytes for this command did not change.
- 7.2.2.4 The FCPARMS, DECEL_OFF, DECEL_ON, HELIX, VERSION, and PHASE commands were added.

7.2.3 CBF File Format Version 4.0 was used beginning June 15, 2015

- 7.2.3.1 Does not support Arc, arc5b circle, circle5b, helix, helix5b.