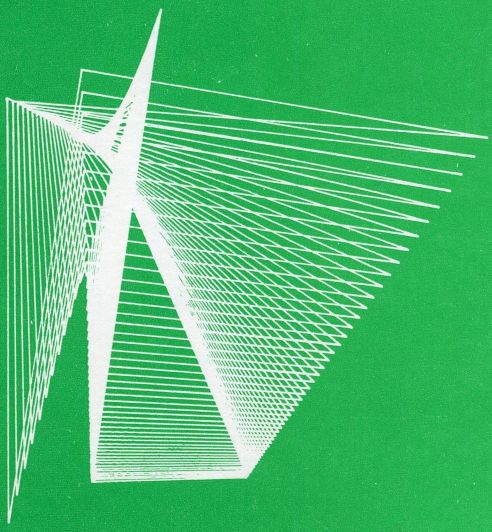
TEKTRONIX®

Reference Guide to

4051 BASIC



OPERATORS

Arithmetic	Operator	Example	Result
	↑	3↑2	9
	*	4*3	12
	/	12/4	3
	+	5+2	7
	–	6–5	1
	MIN	–3 MIN –4	–4
	MAX	–3 MAX –4	–3

Logical	Operator	Example	Result
	AND	1 AND 0	0
	OR	1 OR 0	1
	NOT	NOT 1	0

Relational	Operator	Example	Result
	=	3 = 4	0
	<>	3 <> 4	1
	<	3 < 4	1
	>	3 > 4	0
	=>	3 => 4	0
	=<	3 =< 4	1

ASSIGNMENTS

Numeric

LET	LET A = 5	Assigns the numeric constant 5 to the variable A.
	Y=X↑2+3*X+5	Assigns the result of the numeric expression X↑2+3*X+5 to the variable Y.

String

DIM	DIM A$(8),B$(200)	Dimensions A$ to 8 characters maximum and B$ to 200 characters maximum.
LET	LET C$ = "Bob Edge"	Assigns the string "Bob Edge" to C$. The variable C$ is automatically dimensioned to 72 characters if not previously dimensioned.

Array

DIM	DIM X(12),Y(2,2)	Dimensions X as a 12 element single dimension array and Y as a two by two matrix.
LET	LET X(1)=SIN(45)	Assigns the sine of 45 (degrees, radians, or grads) to the first element in array X.
	Y=10*RND(1)	Assigns the same random number between 0 and 10 to each element in array Y.

ENVIRONMENTAL

INIT	INI	Returns the system environmental parameters to a known state.
FUZZ	FUZ 5,1.0E−10	Sets the comparison standard for non-zero numbers to 5 digits and the standard for zero comparisons to ±1.0E−10.
SET	SET RADIAN	Sets the trigonometric units to radians.
	SET DEGREE	Sets the trigonometric units to degrees.
	SET GRAD	Sets the trigonometric units to grads.
	SET KEY	Enables the user-definable keys during program execution.
	SET NOKEY	Disables the user-definable keys during program execution.
	SET TRACE	Sets the trace debugging feature.
	SET NORMAL	Disables the trace debugging feature.
	SET CASE	Lower case letters are equal to upper case letters.
	SET NOCASE	Lower case letters are not equal to upper case letters.
"ALPHAFONT"	PRI @32,18:0	Selects U.S. Font.
	PRI @32,18:1	Selects Scandinavian Font.
	PRI @32,18:2	Selects German Font.
	PRI @32,18:3	Selects General European Font.
	PRI @32,18:4	Selects Spanish Font.
	PRI @32,18:5	Selects Graphics Symbols Font.
"Tape Status"	PRI @33,0:0,0,0	256 byte physical record, checksum, header format.
	PRI @33,0:1,1,1	128 byte physical record, no checksum, non-header format.
"PAGE FULL"	PRI @32,26:0	Blinking "F"
	PRI @32,26:1	HOME
	PRI @32,26:2	PAGE
	PRI @32,26:3	COPY and PAGE

DELIMITERS

ASCII I/O Delimiters

PRI @37,26:0	Sets Carriage Return (CR) as the delimiter for all ASCII Input/Output operations. An "at" sign (@) must be specified in the I/O address.
PRI @37,26:1	Sets Carriage Return/Line Feed (CR/LF) as the delimiter for all ASCII Input/Output operations. An "at" sign must be specified in the I/O address.

Alternate Delimiters for INPUT, OLD, and APPEND

PRI @37,0:3,4,7	Sets the alternate record separator to decimal 3 (ETX End of Text), the alternate End of File mark to decimal 4 (EOT End of Transmission), and the character to be deleted to decimal 7 (BEL Bell). These delimiters are used in INPUT, OLD, and APPEND operations when a percent sign (%) is specified in the I/O address.

PROGRAM CONTROL

RUN	RUN	Places the system under program control.
STOP	STO	Stops program execution.
END	END	Ends program execution.
FOR 100 NEXT 500	FOR I=1 TO 10 STE 2 NEX I	Executes the statements between lines 100 and 500 five times.
GO TO	GOTO 500	Transfers control to line 500.
	GOTO X OF 100,200	Transfers control to line 100 if X = 1 or to line 200 if X = 2.
GOSUB	GOS 2000	Transfers control to line 2000, the beginning of a subroutine.
	GOS X OF 100,200	Transfers control to line 100 if X = 1 or to line 200 if X = 2.
RETURN	RET	Returns control to the statement following a matching GOSUB or returns control to the GS keyboard.
IF...THEN	IF A = B THEN 360	If the value of A equals the value of B, then control is transferred to line 360.

SYSTEM CONTROL

System Control

CALL	CAL "FIX IT",M,R,W	System control is passed to a routine called "FIX IT." The data items assigned to the variable M, R, and W are passed to the routine as the routine executes.
COPY	COP	Causes an attached Hard Copy Unit to make a paper copy of information on the GS display.
HOME	HOM	Returns the GS display cursor to the home position.
	HOM @16:	Sends a HOME command to device number 16 on the GPIB.
PAGE	PAG	Erases the GS display and returns the cursor to the home position.
	PAG @16:	Sends a PAGE command to device number 16 on the GPIB.

INTERRUPTS

ON...THEN	10 ON SRQ THE 50	Transfers control to line 50 when SRQ (Service Request) is activated on the GPIB.
	20 ON EOI THE 60	Transfers control to line 60 when EOI (End or Identify) is activated on the GPIB.
	30 ON EOF(0) THE 70	Transfers control to line 70 when an End of File character is found on the internal magnetic tape.
	40 ON SIZE THE 80	Transfers control to line 80 when a size error occurs.
OFF	OFF SRQ	Disables the response to SRQ (Service Request).
POLL	POL A,B;5;10;15	Executes a serial poll for devices 5,10, and 15 on the GPIB in that order. Returns a 1 to the variable A if device 5 is requesting service, a 2 if device 10 is requesting service, and a 3 if device 15 is requesting service. The peripheral status byte is assigned to B.
WAIT	WAI	Delays program execution until an SRQ, EOI, EOF, or SIZE interrupt occurs.

PROGRAM EDITING

LIST	LIS	Lists the current BASIC program on the GS display.
	LIS 300	Lists line 300 on the GS display.
	LIS 300,400	Lists lines 300 through 400 on the GS display.
	LIS @16:	Sends a list of the current BASIC program to device number 16 on the GPIB.
REMARK	REM Fetch Data	Indicates the next routine is a fetch data routine.
RENUMBER	REN	Renumbers all program lines in memory starting with line number 100. The new numbers start at 100 and increase with an increment of 10.
	REN 2000,5,90	Renumbers all program lines in memory starting with line number 90. The new numbers start at 2000 and increase with an increment of 5.

MEMORY

Memory Management

DELETE	DEL A,B,C$	Deletes the variables A,B, and C$ from memory.
	DEL 100,200	Deletes program lines 100 through 200 from memory.
	DEL ALL	Deletes all program lines and variables from memory.
MEMORY	MEM	Returns the number of free bytes remaining in memory.
SPACE	SPA	Returns the number of bytes required to store the current BASIC program in external ASCII format.

Memory Allocation

Numeric variable = 13 bytes

String variable = (string dimension +18) bytes

Array variable = ((no. of rows x no. of columns x 8) +18) bytes

MATH FUNCTIONS

Standard Math Functions

ABS	(X)	Returns the absolute value of X.
EXP	(X)	Returns the value of the base e raised to the X power (e^X).
INT	(X)	Returns the largest integer without exceeding X.
LGT	(X)	Returns the logarithm of X to the base 10.
LOG	(X)	Returns the logarithm of X to the base e.
PI		Returns 3.14159265359.
RND	(X)	Returns a random number between 0 and 1.
		X>0 Fixed starting point.
		X=0 Reset to fixed starting point.
		−1<X<0 Selectable starting point.
		X≤−1 Random starting point.
SGN	(X)	Returns +1 if X is positive, 0 if X is 0, and −1 if X is negative.
SQR	(X)	Returns the square root of X.

Trigonometric Functions

SIN	(X)	Returns the sine of X.
COS	(X)	Returns the cosine of X.
TAN	(X)	Returns the tangent of X.
ASN	(X)	Returns the arc sine of X.
ACS	(X)	Returns the arc cosine of X.
ATN	(X)	Returns the arc tangent of X.

NOTE: The result returned by each trigonometric function depends on the RAD, DEG, GRAD environmental parameter. See SET under ENVIRONMENTAL.

Matrix Functions

SUM	(X)	Returns the algebraic sum of the elements in array X.

User-Definable Functions

DEF FN	100 DEF FNA(X)=5↑X	Defines the function of A as 5↑X.
	110 J=FNA(7)	Evaluates the function of A (5↑X) using 7 for the value of X. The result (78125) is assigned to the variable J.

GENERAL INFORMATION

Numeric Accuracy = 14 digits	
Numeric Range = ±8.988E±307	
Numeric Variables and Array Variables	A,A0 – A9 . . . Z,Z0 – Z9
String Variables	A$ – Z$

Parenthesis ( ) , Braces { }, and Brackets [ ] are treated the same.

This document is a summary of the 4051 Graphic System BASIC language. Refer to the 4051 Graphic System Reference Manual for a complete description of the language.

TABLES

ASCII CODE CHART

BITS B4 B3 B2 B1	B7 B6 B5 = 0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER CASE	
0 0 0 0	NUL 0	DLE 16	SP 32	0 48	@ 64	P 80	\ 96	p 112
0 0 0 1	SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113
0 0 1 0	STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114
0 0 1 1	ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115
0 1 0 0	EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116
0 1 0 1	ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117
0 1 1 0	ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118
0 1 1 1	BEL 7	ETB 23	' 39	7 55	G 71	W 87	g 103	w 119
1 0 0 0	BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120
1 0 0 1	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1 0 1 0	LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1 0 1 1	VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123
1 1 0 0	FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	¦ 124
1 1 0 1	CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125
1 1 1 0	SO 14	RS 30	. 46	> 62	N 78	∧ 94	n 110	~ 126
1 1 1 1	SI 15	US 31	/ 47	? UNL 63	O 79	UNT 95	o 111	RUBOUT (DEL) 127
	UNIVERSAL COMMANDS		LISTEN ADDRESSES		TALK ADDRESSES		SECONDARY ADDRESSES	

DISPLAY CONTROL

Control Character	Keyboard Input	Displayed Character	Function Performed
BELL (BELL)	CTRL G	G	Rings bell
BS (Backspace)	CTRL H	H	Backspaces the cursor
HT (Horizontal tab)	CTRL I	I	Tabs cursor to next tab stop
LF (Linefeed)	CTRL J	J	Moves cursor down one line
VT (Vertical tab)	CTRL K	K	Moves cursor up one line
FF (Form feed)	CTRL L	L	Erases screen and moves cursor up to Home
CR (Carriage Return)	CTRL M	Does not display character	Performs same function as RETURN key
RS (Record Separator)	CTRL ↑	↑	Returns the cursor to the HOME position
CR/LF	CTRL RUBOUT	—	Moves cursor to the left margin and down one line

MAGNETIC TAPE

File Creation and Maintenance

FIND	FIN 0	Rewinds the internal magnetic tape.
	FIN 5	Finds file 5 and opens the file for access.
	FIN @10:7	Sends a find file 7 command to device 10 on the GPIB.
MARK	MAR 2,5000	Creates two new files on the internal magnetic tape starting at the present position of the tape head. 5000 bytes of storage is reserved for each file.
	MAR @10:1,SPA	Creates one new file on external tape unit number 10. Enough space is reserved to save the current BASIC program.
KILL	KIL 5	Kills file 5 on the internal magnetic tape.
	KIL @10:7	Sends a kill file 7 command to device 10 on the GPIB.
TLIST	TLI	Lists the internal magnetic tape directory on the GS display.
	TLI @12:	Sends a copy of the internal magnetic tape directory to device 12 on the GPIB.
TYP	TYP(0)	Returns the next data item type in the current internal magnetic tape file. 0 = Empty file or file not open. 1 = End of File. 2 = ASCII data. 3 = Binary numeric data. 4 = Binary character string.
CLOSE	CLO	Closes all internal tape and disk files.

BASIC Program Files — See SAVE and OLD

ASCII Data Files — See INPUT and PRINT

Binary Data Files — See READ and WRITE

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INPUT

BASIC Programs

OLD	OLD	Loads a BASIC program into memory from the internal magnetic tape.
	OLD @10:	Loads a BASIC program into memory from device 10 on the GPIB.
	OLD @40:	Loads a BASIC program into memory from the data communications interface.
APPEND	APP 500	Adds program lines from the current internal tape file to the program currently in memory. The first line coming in overwrites the target statement 500. The renumber increment is 10 by default.
	APP @10:500,5	Adds the program lines from the current file in device 10 to the program currently in memory. The first line coming in overwrites the target statement 500. The renumber increment is 5.

ASCII Data

INPUT	INP M,R,W$	Inputs two numbers and a character string from the GS keyboard.
	INP @33:M,C,D$	Inputs two numbers and a character string from the current internal magnetic tape ASCII data file.
	INP @10:J,R,K$	Inputs two numbers and a character string from device number 10 on the GPIB.
	INP @40:G,R	Inputs two numbers from the data communications interface.

Binary Data

READ	REA J,D,G$	Assigns two numbers and a character string to the variables J, D, and G$ from the DATA statement.
	REA @33:B$,E$	Reads two character strings from the current magnetic tape binary file.
	REA @10:S,B	Reads two numbers from device 10 on the GPIB.

Byte Transfer over the GPIB

RBYTE	RBY J,M	Receives the decimal equivalent of two data bytes over the GPIB and assigns the data bytes to J and M.

OUTPUT

BASIC Programs

SECRET	SEC	Makes the current BASIC program secret.
SAVE	SAV	Sends a copy of the current BASIC program to the internal magnetic tape.
	SAV @10:500,600	Sends a copy of program lines 500 through 600 to ex-device 10 on the GPIB.

ASCII Data

PRINT	PRI "Jack",G;	Sends the character string "Jack" and the value assigned to G to the GS display. The comma specifies a TAB. The semicolon suppresses the carriage return.
	PRI @33:R,A,S$	Sends the data assigned to the variables R,A, and S$ to the internal magnetic tape as a logical record.
PRINT USING	PRI USI "4A":B$	Prints the character string assigned to B$ on the GS display using the format specified by the format string "4A".
	PRI@10: USI 250:M5	The numeric data assigned to M5 is sent to device 10 on the GPIB using the format specified in line 250, an IMAGE statement.
IMAGE	IMA 5X,FD.3D,2A	Specifies a print format to be used in a PRINT USING statement.

Binary Data

WRITE	WRI 56,"DATA",7	Sends the data items 56, "DATA", and 7 to the internal magnetic tape in binary format.
	WRI @10:A$	Sends the character string assigned to A$ to device 10 on the GPIB in binary format.

Byte Transfer over the GPIB

WBYTE	WBY @42:65,–66	Issues the primary listen address for device 10 (decimal 42) over the GPIB with ATN activated. The binary byte decimal 65 is issued next, followed by decimal 66 with EOI activated.
	WBY %68,37:	Issues the primary talk address for device 4 (decimal 68) and the primary listen address for device 5 (decimal 37) over the GPIB with ATN activated. The % sign tells the controller to get off the bus.

GRAPHICS

Graphics Environmental Parameters

VIEWPORT	VIE 0,50,0,100	Sets the GS display drawing boundaries as follows: X-min. = 0 GDU's X-max. = 50 GDU's Y-min. = 0 GDU's Y-max. = 100 GDU's
WINDOW	WIN 0,10,0,50	Sets the window boundaries as follows: X-min. = 0 UDU's X-max. = 10 UDU's Y-min. = 0 UDU's Y-max. = 50 UDU's
SCALE	SCA 1,2	Sets the horizontal scale factor to 1 and the vertical scale factor to 2. Scale Factor = $\frac{\text{UDU's}}{\text{GDU's}}$
"ALPHASCALE"	PRI @16,17:X,Y	Sends alphanumeric scale information to device 16 on the GPIB. The horizontal scale factor X is sent first, followed by the vertical scale factor Y.
ROTATE	ROT 45	Sets the GS display rotation angle to 45 (radians, degrees, or grads).
"ALPHAROT"	PRI @16,25:45	Sets the alpharotation parameter on device 16 to 45 degrees.

Graphics Input

INPUT	INPUT@16:X,Y	Inputs the graphic page size from device 16 on the GPIB. The horizontal dimension is assigned to X; the vertical dimension is assigned to Y.
GIN	GIN X,Y	Records the position of the graphic point on the GS display in UDU's. The horizontal coordinate is assigned to X. The vertical coordinate is assigned to Y.
	GIN @16:X,Y	Records the position of the graphic point on device 16. The horizontal coordinate is assigned to X; the vertical coordinate is assigned to Y.

GRAPHICS (Cont)

Graphics Input (cont)

POINTER	POI X,Y,Z$	Displays the graphic cursor on the GS display and records the coordinates of the graphic point when a key is pressed. The horizontal coordinate in UDU's is assigned to X; the vertical coordinate in UDU's is assigned to Y; the key symbol is assigned to Z$.

Graphics Output

NOTE: All coordinates are specified in user data units.

MOVE	MOV X,Y	Moves the graphic point to the absolute coordinates X,Y.
	MOV @16:X,Y	Moves the graphic point on device 16 to the absolute coordinates X,Y.
RMOVE	RMO X,Y	Moves the graphic point on the GS display to a position X units horizontally and Y units vertically from its present position.
	RMO @16:X,Y	Moves the graphic point on device 16 to a position X units horizontally and Y units vertically from its present position.
DRAW	DRA X,Y	Draws a line from the present position of the graphic point to the coordinates X,Y.
	DRA @16:X,Y	Draws a line from the present position of the graphic point on device 16 to the coordinates X,Y.
RDRAW	RDR X,Y	Draws a line to a position which is X units horizontally and Y units vertically from the present position of the graphic point on the GS display.
	RDR @16:X,Y	Draws a line to a position which is X units horizontally and Y units vertically from the present position of the graphic point on device 16.
AXIS	AXI 10,0,65,50	Creates an X-Y axis on the GS display with the following characteristics: X tic interval = 10 Y tic interval = 0 X axis intercept = 65 Y axis intercept = 50

STRING FUNCTIONS

LEN	LEN A$	Returns the number of characters currently assigned to A$.
POS	Y=POS(A$,B$,X)	The string assigned to A$ is searched starting at character position X. The first character position occurance of the sub-string B$ is assigned to Y.
SEG	C$=SEG(A$,6,10)	A 10 character segment of A$ is assigned C$. The segment starts at position 6.
REP	A$=REP(B$,6,10)	Part of A$ is replaced by B$. Starting at position 6, 10 characters are deleted before B$ is inserted.
VAL	VAL "1234"	The character string "1234" is converted to the number 1234.
STR	A$=STR 1234	The number 1234 is converted to the string " 1234" and assigned to A$.
ASC	ASC "A"	Returns the number 65, the decimal equivalent of "A".
CHR	A$=CHR(66)	Converts decimal 66 to its ASCII character equivalent (B) and assigns "B" to A$.

CHARACTER PRIORITY

HIGHEST PRIORITY		
DEL (Delete or Rub Out)	C or c	SP (Space, Blank)
~ (Tilde)	B or b	US (Unit Separator)
} (Right Brace)	A or a	RS (Record Separator)
| (Vertical Bar)	@	GS (Group Separator)
{ (Left Brace)	?	FS (File Separator)
` (Accent Grave)	=	ESC (Escape)
_ (Underscore)	;	SUB (Substitute)
↑ (Up Arrow)	:	EM (End of Medium)
] (Right Bracket)	9	CAN (Cancel)
\ (Reverse Slash)	8	ETB (End of Transmission Block)
[(Left Bracket)	7	SYN (Synchronous idle)
Z or z	6	NAK (Negative Acknowledge)
Y or y	5	DC4 (Device Control 4)
X or x	4	DC3 (Device Control 3)
W or w	3	DC2 (Device Control 2)
V or v	2	DC1 (Device Control 1)
U or u	1	DLE (Data Link Escape)
T or t	Ø (Zero)	SI (Shift In)
S or s	/	SO (Shift Out)
R or r	.	CR (Carriage Return)
Q or q	-	FF (Form Feed)
P or p	,	VT (Vertical Tab)
O or o	+	LF (Line Feed)
N or n	*	HT (Horizontal Tab)
M or m	)	BS (Backspace)
L or l	(	BEL (Bell)
K or k	'	ACK (Acknowledge)
J or j	&	ENQ (Enquire, also known as Who-Are-You)
I or i	%	EOT (End of transmission)
H or h	$	ETX (End of Text)
G or g	#	STX (Start of Text)
F or f	"	SOH (Start of Heading)
E or e	!	NUL (Null)
D or d		LOWEST PRIORITY

NOTE: If NOCASE is set, lower case letters have a higher priority over their equivalent upper case letters (i.e., "w") "W" is true).