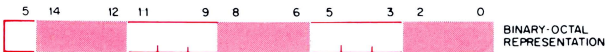


**digital****pdp11****PROGRAMMING CARD**

FOR FAMILY OF PDP-11 COMPUTERS

**WORD FORMAT:**

Mode	Name	Symbolic	Description
0	register	R	(R) is operand [ex. R2=%2]
1	register deferred	(R)	(R) is address
2	auto-increment	(R)+	(R) is adrs; (R) + (1 or 2)
3	auto-incr deferred	@(R)+	(R) is adrs of adrs; (R) + 2
4	auto-decrement	-(R)	(R) - (1 or 2); (R) is adrs
5	auto-decr deferred	@-(R)	(R) - 2; (R) is adrs of adrs
6	index	X(R)	(R) + X is adrs
7	index deferred	@X(R)	(R) + X is adrs of adrs

**PROGRAM COUNTER ADDRESSING: Reg = 7**

2	immediate	#n	operand n follows instr
3	absolute	@#A	address A follows instr
6	relative	A	instr adrs + 4 + X is adrs
7	relative deferred	@A	instr adrs + 4 + X is adrs of adrs

**LEGEND:****Op Codes**

- = 0 for word/1 for byte
- SS = source field (6 bits)
- DD = destination field (6 bits)
- R = gen register (3 bits), 0 to 7
- XXX = offset (8 bits), +127 to -128
- N = number (3 bits)
- NN = number (6 bits)

**Operations**

- ( ) = contents of
- s = contents of source
- d = contents of destination
- r = contents of register
- ← = becomes
- X = relative address
- % = register definition

**Boolean**

- Λ = AND
- V = inclusive OR
- ∨ = exclusive OR
- ~ = NOT

**Condition Codes**

- \* = conditionally set/cleared
- = not affected
- 0 = cleared
- 1 = set

**NOTE:**

- ▲ = Applies to the 11/35, 11/40, 11/45 & 11/70 computers
- = Applies to the 11/45 & 11/70 computers

**digital equipment corporation**

MAYNARD, MASSACHUSETTS

July 1975

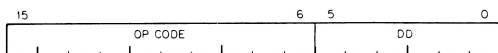


**NUMERICAL OP CODE LIST :**

OP Code	Mnemonic	OP Code	Mnemonic	OP Code	Mnemonic	
00 00 00	HALT	00 60 DD	ROR	10 40 00	} EMT	
00 00 01	WAIT	00 61 DD	ROL	10 41 00		
00 00 02	RTI	00 62 DD	ASR	10 43 77		
00 00 03	BPT	00 63 DD	ASL	10 44 00	} TRAP	
00 00 04	IOT	00 64 NN	MARK	10 45 00		
00 00 05	RESET	00 65 SS	MFPI	10 47 77		
00 00 06	RTT	00 66 DD	MTPI			
00 00 07	} (unused)	00 67 DD	SXT			
00 00 77						
00 01 DD	JMP	00 70 00	} (unused)	10 50 DD	CLRB	
00 02 OR	RTS	00 77 77			10 51 DD	COMB
00 02 10	} (unused)	01 SS DD	MOV	10 52 DD	INCB	
00 02 27			02 SS DD	CMP	10 53 DD	DECB
			03 SS DD	BIT	10 54 DD	NEGB
00 02 3N	SPL	04 SS DD	BIC	10 55 DD	ADCB	
00 02 40	NOP	05 SS DD	BIS	10 56 DD	SBCB	
00 02 41	} cond codes	06 SS DD	ADD	10 57 DD	TSTB	
00 02 77			07 OR SS	MUL	10 60 DD	RORB
			07 1R SS	DIV	10 61 DD	ROLB
			07 2R SS	ASH	10 62 DD	ASRB
00 03 DD	SWAB	07 3R SS	ASHC	10 63 DD	ASLB	
00 04 XXX	BR	07 4R DD	XOR	10 64 00	} (unused)	
00 10 XXX	BNE	07 50 OR	FADD	10 64 77		
00 14 XXX	BEQ	07 50 1R	FSUB	10 65 SS	MFPD	
00 20 XXX	BGE	07 50 2R	FMUL	10 66 DD	MTPD	
00 24 XXX	BLT	07 50 3R	FDIV			
00 30 XXX	BGT	07 50 40	} (unused)	10 67 00	} (unused)	
00 34 XXX	BLE	07 67 77				10 77 77
00 4R DD	JSR	07 7R NN	SOB	11 SS DD	MOVB	
00 50 DD	CLR	10 00 XXX	BPL	12 SS DD	CMPB	
00 51 DD	COM	10 04 XXX	BMI	13 SS DD	BITB	
00 52 DD	INC	10 10 XXX	BHI	14 SS DD	BICB	
00 53 DD	DEC	10 14 XXX	BLOS	15 SS DD	BISB	
00 54 DD	NEG	10 20 XXX	BVC	16 SS DD	SUB	
00 55 DD	ADC	10 24 XXX	BVS	17 00 00	} floating point	
00 56 DD	SBC	10 30 XXX	BCC, BHIS	17 01 00		
00 57 DD	TST	10 34 XXX	BCS, BLO	17 77 77		

**TRAP VECTORS:**

000	(reserved)	114	Memory Parity
004	Time Out & other errors	240	PIRQ, prog int req
010	illegal & reserved instr	244	Floating Point
014	BPT instruction	250	Memory Management
020	IOT instruction		
024	Power Fail		
030	EMT instruction		
034	TRAP instruction		

**SINGLE OPERAND:** OPR dst

Mnemonic	Op Code	Instruction	dst Result	N	Z	V	C
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**General**

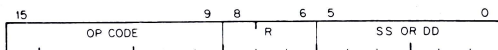
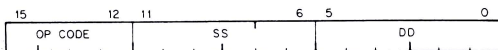
CLR(B)	■ 050DD	clear	0	0	1	0	0
COM(B)	■ 051DD	complement (1's)	$\sim d$	*	*	0	1
INC(B)	■ 052DD	increment	$d + 1$	*	*	*	-
DEC(B)	■ 053DD	decrement	$d - 1$	*	*	*	-
NEG(B)	■ 054DD	negate (2's compl)	$-d$	*	*	*	*
TST(B)	■ 057DD	test	d	*	*	0	0

**Rotate & Shift**

ROR(B)	■ 060DD	rotate right	$\rightarrow C, d$	*	*	*	*
ROL(B)	■ 061DD	rotate left	$C, d \leftarrow$	*	*	*	*
ASR(B)	■ 062DD	arith shift right	$d/2$	*	*	*	*
ASL(B)	■ 063DD	arith shift left	$2d$	*	*	*	*
SWAB	0003DD	swap bytes		*	*	*	0

**Multiple Precision**

ADC(B)	■ 055DD	add carry	$d + C$	*	*	*	*
SBC(B)	■ 056DD	subtract carry	$d - C$	*	*	*	*
▲SXT	0067DD	sign extend	0 or -1	-	*	0	-

**DOUBLE OPERAND:** OPR src, dst      OPR src, R or OPR R, dst

Mnemonic	Op Code	Instruction	Operation	N	Z	V	C
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**General**

MOV(B)	■ 1SSDD	move	$d \leftarrow s$	*	*	0	-
CMP(B)	■ 2SSDD	compare	$s - d$	*	*	*	*
ADD	06SSDD	add	$d \leftarrow s + d$	*	*	*	*
SUB	16SSDD	subtract	$d \leftarrow d - s$	*	*	*	*

**Logical**

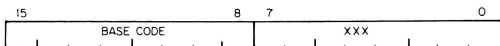
BIT(B)	■ 3SSDD	bit test (AND)	$s \wedge d$	*	*	0	-
BIC(B)	■ 4SSDD	bit clear	$d \leftarrow (\sim s) \wedge d$	*	*	0	-
BIS(B)	■ 5SSDD	bit set (OR)	$d \leftarrow s \vee d$	*	*	0	-

**▲Register**

MUL	070RSS	multiply	$r \leftarrow r \times s$	*	*	0	*
DIV	071RSS	divide	$r \leftarrow r/s$	*	*	*	*
ASH	072RSS	shift arithmetically		*	*	*	*
ASHC	073RSS	arith shift combined		*	*	*	*
XOR	074RDD	exclusive OR	$d \leftarrow r \oplus d$	*	*	0	-

**BRANCH:** B -- location

If condition is satisfied:  
 Branch to location,  
 New PC  $\leftarrow$  Updated PC + (2 x offset)  
 $\text{adrs of br instr} + 2$



Op Code = Base Code + XXX

Mnemonic	Base Code	Instruction	Branch Condition
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**Branches**

BR	000400	branch (unconditional)	(always)
BNE	001000	br if not equal (to 0)	$\neq 0$ $Z = 0$
BEQ	001400	br if equal (to 0)	$= 0$ $Z = 1$
BPL	100000	branch if plus	$+$ $N = 0$
BMI	100400	branch if minus	$-$ $N = 1$
BVC	102000	br if overflow is clear	$V = 0$
BVS	102400	br if overflow is set	$V = 1$
BCC	103000	br if carry is clear	$C = 0$
BCS	103400	br if carry is set	$C = 1$

**Signed Conditional Branches**

BGE	002000	br if greater or eq (to 0)	$\geq 0$ $N \neq V = 0$
BLT	002400	br if less than (0)	$\leq 0$ $N \neq V = 1$
BGT	003000	br if greater than (0)	$> 0$ $Z \vee (N \neq V) = 0$
BLE	003400	br if less or equal (to 0)	$\leq 0$ $Z \vee (N \neq V) = 1$

**Unsigned Conditional Branches**

BHI	101000	branch if higher	$>$ $C \vee Z = 0$
BLOS	101400	branch if lower or same	$\leq$ $C \vee Z = 1$
BHIS	103000	branch if higher or same	$\geq$ $C = 0$
BLO	103400	branch if lower	$<$ $C = 1$

**JUMP & SUBROUTINE:**

Mnemonic	Op Code	Instruction	Notes
JMP	0001DD	jump	PC $\leftarrow$ dst
JSR	004RDD	jump to subroutine	} use same R
RTS	00020R	return from subroutine	
▲MARK	0064NN	mark	aid in subr return
▲SOB	077RNN	subtract 1 & br (if $\neq 0$ )	$(R) - 1$ , then if $(R) \neq 0$ : PC $\leftarrow$ Updated PC - (2 x NN)

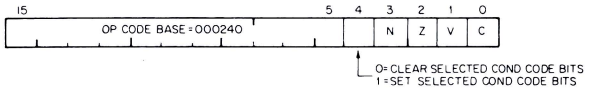
**TRAP & INTERRUPT:**

Mnemonic	Op Code	Instruction	Notes
EMT	104000 to 104377	emulator trap (not for general use)	PC at 30, PS at 32
TRAP	104400 to 104777	trap	PC at 34, PS at 36
BPT	000003	breakpoint trap	PC at 14, PS at 16
IOT	000004	input/output trap	PC at 20, PS at 22
RTI	000002	return from interrupt	
▲RTT	000006	return from interrupt	inhibit T bit trap

**MISCELLANEOUS:**

Mnemonic	Op Code	Instruction
HALT	000000	halt
WAIT	000001	wait for interrupt
RESET	000005	reset external bus
NOP	000240	(no operation)
●SPL	00023N	set priority level (to N)
▲MFPI	0065SS	move from previous instr space
▲MTPI	0066DD	move to previous instr space
●MFPD	1065SS	move from previous data space
●MTPD	1066DD	move to previous data space

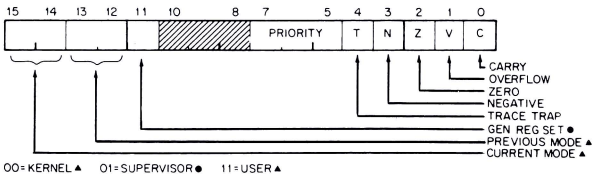
**CONDITION CODE OPERATORS:**



Mnemonic	Op Code	Instruction	N	Z	V	C
CLC	000241	clear C	-	-	-	0
CLV	000242	clear V	-	-	0	-
CLZ	000244	clear Z	-	0	-	-
CLN	000250	clear N	0	-	-	-
CCC	000257	clear all cc bits	0	0	0	0
SEC	000261	set C	-	-	-	1
SEV	000262	set V	-	-	1	-
SEZ	000264	set Z	-	1	-	-
SEN	000270	set N	1	-	-	-
SCC	000277	set all cc bits	1	1	1	1

**PROCESSOR REGISTER ADDRESSES:**

**Processor Status Word**  
PS - 777 776



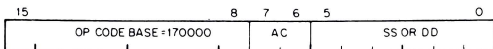
▲ Stack Limit Register — 777 774

● Program Interrupt Request — 777 772

General Registers	R0 — 777 700	R4 — 777 704
(console use only)	R1 — 777 701	R5 — 777 705
	R2 — 777 702	R6 — 777 706
(not for 11/45)	R3 — 777 703	R7 — 777 707

**Console Switches & Display Register — 777 570**

**PDP-11/45, 11/70 FLOATING POINT PROCESSOR:**



Mnemonic	Op Code	Instruction	Operation
CFCC	170000	copy fl cond codes	
SETF	170001	set floating mode	FD ← 0
SETI	170002	set integer mode	FL ← 0
SETD	170011	set fl dbl mode	FD ← 1
SETL	170012	set long integer mode	FL ← 1
LDFPS	1701 src	load FPP prog status	
STFPS	1702 dst	store FPP prog status	
STST	1703 dst	store (exc codes & adrs)	
CLRF, CLRD	1704 fdst	clear floating/double	fdst ← 0
TSTF, TSTD	1705 fdst	test fl/dbl	
ABSF, ABSD	1706 fdst	make absolute fl/dbl	fdst ← fdst
NEGF, NEG D	1707 fdst	negate fl/dbl	fdst ← -fdst
MULF, MUL D	171 (AC) fsrc	multiply fl/dbl	AC ← AC x fsrc
MODF, MOD D	171 (AC + 4) fsrc	multiply & integerize	
ADDF, ADD D	172 (AC) fsrc	add fl/dbl	AC ← AC + fsrc
LDF, LDD	172 (AC + 4) fsrc	load fl/dbl	AC ← fsrc
SUBF, SUB D	173 (AC) fsrc	subtract fl/dbl	AC ← AC - fsrc
CMPF, CMP D	173 (AC + 4) fsrc	compare fl/dbl (to AC)	
STF, STD	174 (AC) fdst	store fl/dbl	fdst ← AC
DIVF, DIV D	174 (AC + 4) fsrc	divide fl/dbl	AC ← AC/fsrc
STEXP	175 (AC) dst	store exponent	
STCFI, STCFL } STCDI, STCDL }	175 (AC + 4) dst	{ store & convert fl or dbl to int or long int	
STCFD, STCDF	176 (AC) fdst	store & convert (dbl-fl)	
LDEXP	176 (AC + 4) src	load exponent	
LDCIF, LDCID } LDCLF, LDCLD }	177 (AC) src	{ load & convert int or long int to fl or dbl	
LDCDF, LDCFD	177 (AC + 4) fsrc	load & convert (dbl-fl)	

**PDP-11/35, 11/40 FLOATING POINT UNIT:**

			N	Z	V	C
FADD	07500R	floating add	*	*	0	0
FSUB	07501R	floating subtract	*	*	0	0
FMUL	07502R	floating multiply	*	*	0	0
FDIV	07503R	floating divide	*	*	0	0

**POWERS OF 2:**

n	2 <sup>n</sup>	n	2 <sup>n</sup>
0	1	10	1,024
1	2	11	2,048
2	4	12	4,096
3	8	13	8,192
4	16	14	16,384
5	32	15	32,768
6	64	16	65,536
7	128	17	131,072
8	256	18	262,144
9	512	19	524,288

**DEVICE REGISTER ADDRESSES:**

Device	Registers	Address	Int Vec- tor	Prior- ity	NPR
CD11	Card Reader, high speed status & control	(CDST) 777 160	230	BR4	X
	column count	(CDCC) 777 162			
	current address	(CDBA) 777 164			
	data	(CDDB) 777 166			
CR11	Card Reader status	(CRS) 777 160	230	BR6	
	buffer, 12-bit char	(CRB1) 777 162			
	buffer, 8-bit char	(CRB2) 777 164			
KW11-L	Line Clock	(LKS) 777 546	100	BR6	
KW11-P	Programmable Clock control & status	772 540	104	BR6	
	count set buffer	772 542			
	counter	772 544			
LA30, LA36, LT33, VT05, VT50	Console Terminal keyboard/reader status	777 560	60	BR4	
	keyboard/reader buffer	777 562			
	printer/punch status	777 564	64	BR4	
	printer/punch buffer	777 566			
LP11, LS11, LV11	Line Printer printer status	777 514	200	BR4	
	printer data	777 516			
PC11	Paper Tape reader status	(PRS) 777 550	70	BR4	
	reader buffer	(PRB) 777 552			
	punch status	(PPS) 777 554	74	BR4	
	punch buffer	(PPB) 777 556			
RK11/ RK05	Disk Cartridge drive status	(RKDS) 777 400	220	BR5	X
	error	(RKER) 777 402			
	control & status	(RKCS) 777 404			
	word count	(RKWC) 777 406			
	current bus adrs	(RKBA) 777 410			
	disk address	(RKDA) 777 412			
	data buffer	(RKDB) 777 416			
RF11/ RS11	Disk disk control status	(DCS) 777 460	204	BR5	X
	word count	(WC) 777 462			
	current mem adrs	(CMA) 777 464			
	disk address	(DAR) 777 466			
	disk adrs ext & error	(DAE) 777 470			
	disk data buffer	(DBR) 777 472			
	maintenance	(MA) 777 474			
	adrs of disk segment	(ADS) 777 476			
RP11-C/Disk RP03, RPR11/ RPR02	device status	(RPDS) 776 710	254	BR5	X
	error	(RPER) 776 712			
	control status	(RPCS) 776 714			
	word count	(RPWC) 776 716			
	bus address	(RPBA) 776 720			
	cylinder address	(RPCA) 776 722			
	disk address	(RPDA) 776 724			
	maintenance 1	(RPM1) 776 726			
	maintenance 2	(RPM2) 776 730			
	maintenance 3	(RPM3) 776 732			
	selected unit cyl adrs	(SUCA) 776 734			
	silos memory	(SILO) 776 736			
RX11/ RX01	Floppy Disk command & status	(RXCS) 777 170	264	BR5	
	data buffer	(RXDB) 777 172			

Device	Registers	Address	Int Vec- tor	Prior- ity	NPR
RJP04/ Disk			254*	BR5**	X
RWP04/ control & status #1	(RPCS1)	776 700			
RP04 word count	(RPWC)	776 702			
UNIBUS address	(RPBA)	776 704			
desired sector/track address	(RPDA)	776 706			
RH11 control & status	(RPCS2)	776 710			
drive status	(RPDS)	776 712			
error register #1	(RPER1)	776 714			
attention summary	(RPAS)	776 716			
look ahead	(RPLA)	776 720			
data buffer	(RPDB)	776 722			
maintenance register	(RPMR)	776 724			
drive type	(RPDT)	776 726			
serial number	(RPSN)	776 730			
offset	(RPOF)	776 732			
desired cylinder	(RPDC)	776 734			
current cylinder	(RPCC)	776 736			
error #2	(RPER2)	776 740			
error #3	(RPER3)	776 740			
ECC position	(RPEC1)	776 744			
ECC pattern	(RPEC2)	776 746			
bus address ext	(RPBAE)	776 750†			
control & status #3	(RPCS3)	776 752†			
RJS04/ Disk			204*	BR5**	X
RWS04/ control & status #1	(RSCS1)	772 040			
RS04 word count	(RSWC)	772 042			
RJS03/ UNIBUS address	(RSBA)	772 044			
RWS03 desired disk adrs	(RSDA)	772 046			
RS03 RH11 control & status	(RSCS2)	772 050			
drive status	(RSDS)	772 052			
error	(RSER)	772 054			
attention summary	(RSAS)	772 056			
look ahead	(RSLA)	772 060			
data buffer	(RSDB)	772 062			
maintenance	(RSMR)	772 064			
drive type	(RSDT)	772 066			
bus address ext	(RSBAE)	772 070†			
control & status #3	(RSCS3)	772 072†			
TJU16/ Tape			224*	BR5**	X
TWU16/ control & status #1	(MTSC1)	772 440			
TU16 word count	(MTWC)	772 442			
UNIBUS address	(MTBA)	772 444			
frame count	(MTFC)	772 446			
RH11 control & status	(MTCS2)	772 450			
drive status	(MTDS)	772 452			
error	(MTER)	772 454			
attention summary	(MTAS)	772 456			
check character	(MTCK)	772 460			
data buffer	(MTDB)	772 462			
maintenance	(MTMR)	772 464			
drive type	(MTDT)	772 466			
serial number	(MTSN)	772 470			
tape control	(MTTC)	772 472			
bus address ext	(MTBAE)	772 474†			
control & status #3	(MTCS3)	772 476†			
TMA11/ Magnetic Tape			224	BR5	X
TU10 status	(MTS)	772 520			
TS03 command	(MTC)	772 522			
byte record cntr	(MTBRC)	772 524			
current mem adrs	(MTCMA)	772 526			
data buffer	(MTD)	772 530			
read lines	(MTRD)	772 532			

\*Jumper Selectable

\*\*Plug Selectable

† Implemented on PDP-11/70 only



Device	Registers	Address	Int Vec- tor	Prior- ity	NPR
TA11	Cassette command & status data buffer	(TACS) (TADB) 777 500 777 502	260	BR6	
TC11/ TU56	DEctape control & status command word count bus address data	(TCST) (TCCM) (TCWC) (TCBA) (TCDT) 777 340 777 342 777 344 777 346 777 350	214	BR6	X

### BM873-YA BOOTSTRAP LOADER:

Starting Address	Device
773 000	RF11
773 010	RK11
773 020	Transfer to address contained in Switch Register
773 030	TC11
773 050	TM11
773 100	RP11
773 144	RC11
773 210	ASR paper tape reader
773 230	TA11
773 312	PC11

### BM873-YB BOOTSTRAP LOADER:

Starting Address	Device
773 000	RJS03/RJS04
773 002	RJS03/RJS04
773 030	RK11
773 032	RK11
773 070	TC11
773 110	TM11
773 136	RF11
773 150	TJU16
773 212	RC11
773 320	RJP04
773 322	RJP04
773 344	Transfer to address in console switch register
773 350	RP11
773 352	RP11
773 510	KL11/DL11
773 524	TA11
773 526	TA11
773 620	PC11

### PDP-11/70 BOOTSTRAP LOADER:

Starting Address 17 765 000

21	8	7	3	2	0
DEVICE TYPE			UNIT #		

Device Type:	1	TM11	6	TWU16
	2	TC11	7	RWP04
	3	RK11	10	RWS03/4
	4	RP11	11	RX11

**ABSOLUTE LOADER****BOOTSTRAP LOADER**

Starting Address: — 500

Memory Size: (

4K 017  
 8K 037  
 12K 057  
 16K 077  
 20K 117  
 24K 137  
 28K 157

(or larger)

Address	Contents	Address	Contents
— 744	016 701	— 764	000 002
— 746	000 026	— 766	— 400
— 750	012 702	— 770	005 267
— 752	000 352	— 772	177 756
— 754	005 211	— 774	000 765
— 756	105 711	— 776	177 560 (TTY)
— 760	100 376		or 177 550(PC11)
— 762	116 162		

773 000 Paper Tape Bootstrap  
 773 100 Disk/DECtape Bootstrap  
 773 200 Card Reader Bootstrap  
 773 300 Cassette Bootstrap  
 773 400 Floppy Disk Bootstrap

**MR11-DB BOOTSTRAP LOADER:**

Starting Address	Device
773 100	RF11
773 110	RK11
773 120	TC11
773 136	TM11
773 154	RP11
773 220	RC11

**7-BIT ASCII CODE:**

Octal Code	Char	Octal Code	Char	Octal Code	Char	Octal Code	Char
000	NUL	040	SP	100	@	140	\
001	SOH	041	!	101	A	141	a
002	STX	042	"	102	B	142	b
003	ETX	043	#	103	C	143	c
004	EOT	044	\$	104	D	144	d
005	ENQ	045	%	105	E	145	e
006	ACK	046	&	106	F	146	f
007	BEL	047	'	107	G	147	g
010	BS	050	(	110	H	150	h
011	HT	051	)	111	I	151	i
012	LF	052	*	112	J	152	j
013	VT	053	+	113	K	153	k
014	FF	054	,	114	L	154	l
015	CR	055	-	115	M	155	m
016	SO	056	.	116	N	156	n
017	SI	057	/	117	O	157	o
020	DLE	060	0	120	P	160	p
021	DC1	061	1	121	Q	161	q
022	DC2	062	2	122	R	162	r
023	DC3	063	3	123	S	163	s
024	DC4	064	4	124	T	164	t
025	NAK	065	5	125	U	165	u
026	SYN	066	6	126	V	166	v
027	ETB	067	7	127	W	167	w
030	CAN	070	8	130	X	170	x
031	EM	071	9	131	Y	171	y
032	SUB	072	:	132	Z	172	z
033	ESC	073	;	133	[	173	{
034	FS	074	<	134	\	174	
035	GS	075	=	135	]	175	}
036	RS	076	>	136	^	176	~
037	US	077	?	137	_	177	DEL