

TABLE 5-6 Control Functions and Microoperations for the Basic Computer

Fetch	$R'T_0:$	$AR \leftarrow PC$	
	$R'T_1:$	$IR \leftarrow M[AR], \quad PC \leftarrow PC + 1$	
Decode	$R'T_2:$	$D_0, \dots, D_7 \leftarrow \text{Decode } IR(12-14),$ $AR \leftarrow IR(0-11), \quad I \leftarrow IR(15)$	
Indirect	$D_7IT_3:$	$AR \leftarrow M[AR]$	
Interrupt:	$T_0T_1T_2(IEN)(FGI + FGO):$	$R \leftarrow 1$	
	$RT_0:$	$AR \leftarrow 0, \quad TR \leftarrow PC$	
	$RT_1:$	$M[AR] \leftarrow TR, \quad PC \leftarrow 0$	
	$RT_2:$	$PC \leftarrow PC + 1, \quad IEN \leftarrow 0, \quad R \leftarrow 0, \quad SC \leftarrow 0$	
Memory-reference:			
AND	$D_0T_4:$	$DR \leftarrow M[AR]$	
	$D_0T_5:$	$AC \leftarrow AC \wedge DR, \quad SC \leftarrow 0$	
ADD	$D_1T_4:$	$DR \leftarrow M[AR]$	
	$D_1T_5:$	$AC \leftarrow AC + DR, \quad E \leftarrow C_{out}, \quad SC \leftarrow 0$	
LDA	$D_2T_4:$	$DR \leftarrow M[AR]$	
	$D_2T_5:$	$AC \leftarrow DR, \quad SC \leftarrow 0$	
STA	$D_3T_4:$	$M[AR] \leftarrow AC, \quad SC \leftarrow 0$	
BUN	$D_4T_4:$	$PC \leftarrow AR, \quad SC \leftarrow 0$	
BSA	$D_5T_4:$	$M[AR] \leftarrow PC, \quad AR \leftarrow AR + 1$	suggest to break these two microoperations into separate steps. BSA will take T4..T6
	$D_5T_5:$	$PC \leftarrow AR, \quad SC \leftarrow 0$	
ISZ	$D_6T_4:$	$DR \leftarrow M[AR]$	
	$D_6T_5:$	$DR \leftarrow DR + 1$	
	$D_6T_6:$	$M[AR] \leftarrow DR, \quad \text{if } (DR = 0) \text{ then } (PC \leftarrow PC + 1), \quad SC \leftarrow 0$	
Register-reference:			
	$D_7IT_3 = r$	(common to all register-reference instructions)	
	$IR(i) = B_i$	($i = 0, 1, 2, \dots, 11$)	
	$r:$	$SC \leftarrow 0$	
CLA	$rB_{11}:$	$AC \leftarrow 0$	
CLE	$rB_{10}:$	$E \leftarrow 0$	
CMA	$rB_9:$	$AC \leftarrow \overline{AC}$	
CME	$rB_8:$	$E \leftarrow \overline{E}$	
CIR	$rB_7:$	$AC \leftarrow \text{shr } AC, \quad AC(15) \leftarrow E, \quad E \leftarrow AC(0)$	
CIL	$rB_6:$	$AC \leftarrow \text{shl } AC, \quad AC(0) \leftarrow E, \quad E \leftarrow AC(15)$	
INC	$rB_5:$	$AC \leftarrow AC + 1$	
SPA	$rB_4:$	If $(AC(15) = 0)$ then $(PC \leftarrow PC + 1)$	
SNA	$rB_3:$	If $(AC(15) = 1)$ then $(PC \leftarrow PC + 1)$	
SZA	$rB_2:$	If $(AC = 0)$ then $PC \leftarrow PC + 1$	
SZE	$rB_1:$	If $(E = 0)$ then $(PC \leftarrow PC + 1)$	
HLT	$rB_0:$	$S \leftarrow 0$	
Input-output:			
	$D_7IT_3 = p$	(common to all input-output instructions)	
	$IR(i) = B_i$	($i = 6, 7, 8, 9, 10, 11$)	
	$p:$	$SC \leftarrow 0$	
INP	$pB_{11}:$	$AC(0-7) \leftarrow INPR, \quad FGI \leftarrow 0$	
OUT	$pB_{10}:$	$OUTR \leftarrow AC(0-7), \quad FGO \leftarrow 0$	
SKI	$pB_9:$	If $(FGI = 1)$ then $(PC \leftarrow PC + 1)$	
SKO	$pB_8:$	If $(FGO = 1)$ then $(PC \leftarrow PC + 1)$	
ION	$pB_7:$	$IEN \leftarrow 1$	
IOF	$pB_6:$	$IEN \leftarrow 0$	