Audio-range frequency-counter subroutine for the Apple II

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This paper describes a 6502 assembly language subroutine that counts the frequency of an oscillating signal in the range of .5 Hz-15 kHz. This routine has applications in experiments in which subjects are required to adjust the frequency of a periodic visual or auditory stimulus and the experimenter would like to obtain a precise record of the frequency after each adjustment (cf. Bowker & Mandler, 1981).

Description. The frequency-counter routine was developed on an Apple II microcomputer with a Mountain real-time clock¹ and was designed to be called from a BASIC language program. In our particular application, the oscillating signals were produced by a Wavetek 136 signal generator and were fed through an amplifier circuit to one of the Apple II game controller inputs (Hex Location \$C063). When called from the BASIC language program, the frequency-count subroutine first examines one of the real-time clock locations (Hex Location \$C0C2) and does not proceed until the value of that location increments. It then counts the number of low-to-high voltage transitions occurring at the game controller input before the next change in the real-time clock location. Each increment in the clock location represents a 16-sec integration interval; we are particularly interested in signals oscillating below 30 Hz. To save time, the more rapidly changing clock locations

can be examined at higher oscillatory frequencies.

Three 8-bit memory locations, including the microprocessor's Y register, count the voltage transitions. Over a 16-sec integration interval, this would theoretically allow the routine to count signals as high as 1 MHz. This is limited in practice by the running speed of the 6502 microprocessor. The routine is capable of reliably counting the frequencies of signals oscillating at rates of up to 15 kHz. This is independent of the signal's waveform (square, sine, triangular). A subroutine available on the Apple II microcomputer (beginning at Hex Location \$E2F2) returns the values of the accumulator (high-order byte) and Y register (low-order byte) to the USR(X) function called from the BASIC language program. Since the frequency is encoded in 3 bytes, calls are required to two separate locations in the assembly language subroutine.

Availability. A listing of the 6502 assembly language subroutine is provided in the appendix along with the BASIC language program. Additional details of the frequency-counting procedure may be obtained from the author, care of the Department of Ophthalmology, Room 568, Waisman Center, University of Wisconsin, Madison, Wisconsin 53706.

REFERENCE

BOWKER, D. O., & MANDLER, M. B. Binocular flicker appears faster than monocular flicker. *Journal of the Optical Society of America*, 1981, **71**, 496-498.

NOTE

1. Mountain Computer, Inc., 300 Harvey West Boulevard, Santa Cruz, California 95060.

Appendix

6502 Frequency-Count Subroutine				BASIC Language Main Routine	
Location	Program Hex Code		Program Mnemonics		
94E0-	A9	00	LDA #\$00	10	REM FREQUENCY COUNT MAIN ROUTINE
94E2-	8D	50 95	STA \$9550	20	REM D.O. BOWKER 2/82
94E5-	8D	51 95	STA \$9551	30	REM SET UP JUMP INSTRUCT FOR USR(X)
94E8-	8D	52 95	STA \$9552	40	POKE 10,76
94EB-	A0	00	LDY #\$00	50	POKE 11,224
94ED-	AE	C2 C0	LDX \$C0C2	60	POKE 12,148
94F0-	EC	C2 C0	CPX \$C0C2	70	REM CALL SUBROUTINE
94F3-	D0	03	BNE \$94F8	80	F1 = USR(0)
94F5-	4C	F0 94	JMP \$94F0	90	REM ACCOUNT FOR ACCUM. SIGN BIT
94F8-	AE	C2 C0	LDX \$C0C2	100	IF F1 < 0 THEN F1 = F1 + 65536
94FB-	EC	C2 C0	CPX \$C0C2	110	REM SET UP NEW JUMP LOCATION
94FE-	F0	07	BEQ \$9507	120	POKE 11,68
9500-	AD	50 95	LDA \$9550	130	POKE 12,149
9503-	20	F2 E2	JSR \$E2F2	140	REM CALL SUBROUTINE AGAIN
9506-	60		RTS	150	F2 = USR(0)
9507-	AD	63 C0	LDA \$C063	160	REM COMPUTE FREQUENCY
950A-	E9	80	SBC #\$80	170	PRINT "FREQUENCY IS "; (F1 + (F2 * 65536)) / 16
950C-	30	05	BMI \$9513	180	END

6502 Frequency-Count Subroutine Continued

Location	Program Hex Code			Program Mnemonics	
950E-	A9	01		LDA	#\$01
9510-	4C	1B	95	JMP	\$951B
9513-	A9	00		LDA	#\$00
9515-	8D	4F	95	STA	\$954F
9518-	4C	FB	94	JMP	\$94FB
951B-	CD	4F	95	CMP	\$954F
951E-	D0	03		BNE	\$9523
9520-	4C	FB	94	JMP	\$94FB
9523-	8D	4F	95	STA	\$954F
9526-	C0	FF		CPY	#\$FF
9528-	D0	15		BNE	\$953F
952A-	A9	FF		LDA	#\$FF
952C-	CD	50	95	CMP	\$9550
952F-	D0	0B		BNE	\$953C
9531-	CD	51	95	CMP	\$9551
9534-	D0	03		BNE	\$9539
9536-	EE	52	95	INC	\$9552
9539-	EE	51	95	INC	\$9551
953C-	EE	50	95	INC	\$9550
953F-	C8			INY	
9540-	4C	FB	94	JMP	\$94FB
9543-	00			BRK	
9544-	AC	51	95	LDY	\$9551
9547-	AD	52	95	LDA	\$9552
954A-	20	F2	E2	JSR	\$E2F2
954D-	60			RTS	
954E-	00			BRK	
954F-	00			BRK	(RESERVED)
9550-	00			BRK	(RESERVED)
9551-	00			BRK	(RESERVED)
9552-	00			BRK	(RESERVED)

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