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TECHNICAL REPORT

CALLED PARTY HOLD DEVICE

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RICHARDS-GEBAUR AIR FORCE BASE, MISSOURI

AUGUST 1976

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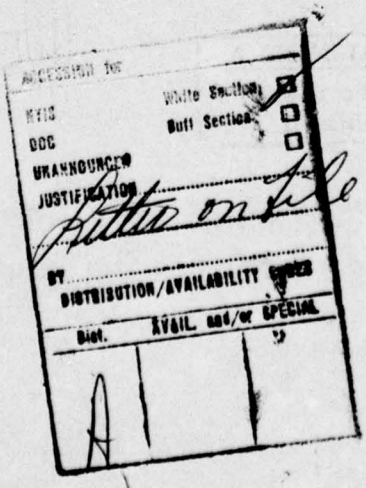

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Called Party Hold

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A Called Party Hold (CPH) device enables a telephone subscriber to hold an incoming call for tracing purposes. This paper describes the affects on AUTOVON of a commercially available CPH device that was in use at Scott AFB. It proposes a solution that will minimize AUTOVON interface problems using a simple dual tone, multi-frequency encoder-decoder scheme.

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ABSTRACT

A Called Party Hold (CPH) device enables a telephone subscriber to hold an incoming call for tracing purposes. This paper describes the affects on AUTOVON of a commercially available CPH device that was in use at Scott AFB. It proposes a solution that will minimize AUTOVON interface problems using a simple dual tone, multi-frequency encoder-decoder scheme.

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This report has been reviewed and is approved for publication and distribution.

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1. INTRODUCTION. This paper covers the background, requirements, and recommendations resulting from the "Called Party Hold" study conducted at Scott AFB, IL. Although the study was requested by Scott AFB, indications are that other Air Force bases may also require this feature.

1.1 Background. In November 1974, AFCS was tasked to investigate the causes of and to develop a resolution for a problem affecting AUTOVON pre-emption operation at Scott AFB. Investigation identified and confirmed the problem to be caused by the AT&T Type T41-S "Called Party Hold" devices then installed at the Scott Dial Central Office (DCO). These devices were used to enable selected subscribers (Security Police, Fire Department, Hospital, etc.) to hold non-routine or emergency calls for tracing in case the calling party hung up before information on his location was obtained.

1.1.1 AT&T T41-S Device. A T41-S device holds the switching train by automatically grounding the "C" lead of the group connector switch as the called party answers. The calling party will remain "held" for as long as the called party is off hook. Since a telephone is multiplied through 10-20 group connector switches (GCS), all GCS's in a group must be equipped with the device. This prerequisite and the non-selective holding of the T41-S equips all telephones connected to the group with the CPH capability, whether it is desired or not.

1.1.2 AUTOVON Interface Problem. When an AUTOVON circuit interfaces with a group equipped with the T41-S device, the device disallows precedence pre-emption on any telephone connected to the group as the switch train cannot be dropped as long as the previous call is in progress. This gives the indication of a stuck sender and results in an incomplete call. An alternate device developed by the 1842 EEG will alleviate this interface problem.

1.2 Alternative. The 1842 EEG investigated alternatives that would remedy the disadvantages of the T41-S device. The study indicated that no commercial device was available with the required characteristics.

A more selective and more flexible device was designed and fabricated from state-of-the-art devices by 1842 EEG engineers and technicians and a prototype was field tested at Scott AFB.

The system uses a "hold-encoder" at each subscriber instrument and a "hold-docoder" on each multiple group connector switch as shown in Figure 1.

The encoder, located at the subcriber, can set or reset only the decoder in use; this means that other connector switches will be free for use while the switch train affected is being held. Any other call (through the unused GCS) will not be held unless antoehr telephone equipped with an encoder activates the "hold-encoder/ decoder". Therefore, the AUTOVON switch can pre-empt a call to any AUTOVON subscriber in the CPH group, except a subscriber having a CPH call in progress.

2. REQUIREMENTS

2.1 Encoder. The encoder interfacing with the system at the called party terminal is shown in Figure 1. Essentially, the encoder is an M-F tone sender that can generate a "hold tone" (fc+fs) and a "release tone" (fc+fr). Each tone is selected by the subscriber by depressing the "hold" or the "release" switch. The block diagram of the encoder is shown in Figure 2. Its complete schematic is shown in Figure 3.

The encoder tone generation is accomplished by a crystal controlled M-F tone generator 1C1. Tone combinations are strap selectable (C1-C4, R1-R4). In the prototype, R4 (941 Hz) was selected as Fc, C1 (1209 Hz) was used for set (Fs) and C3 (1477 Hz) was used as reset (Fs) frequencies. The second integrated circuit, 1C2, provided necessary impedance matching. The encoder was connected to the "R" and "B" terminals of the "called" party telephone set. The encoder is battery operated and was packaged in a 1-1/2" x 2-1/4" x 4" utility box. Output level was 8 dBm into 600 ohms. Encoder strapping options and frequency selected are shown in Table 1.

2.2 Decoder. The decoder was designed to recognize the "hold" and "release" tones generated by the encoder when these tones are present in the talk path (T&R lines). When a "hold" tone is detected, the "C" lead of the affected group connector is grounded. This action will cause the switching train to remain connected for tracing purposes even if the calling party hangs up. If a "release" tone is detected on the talk path, or if the decoder reset switch is depressed, the "C" lead ground will be opened, normalizing the circuit. Hence, "hold" control is confined to the selected subscriber and "release" control can be done at either the subscriber or DCO.

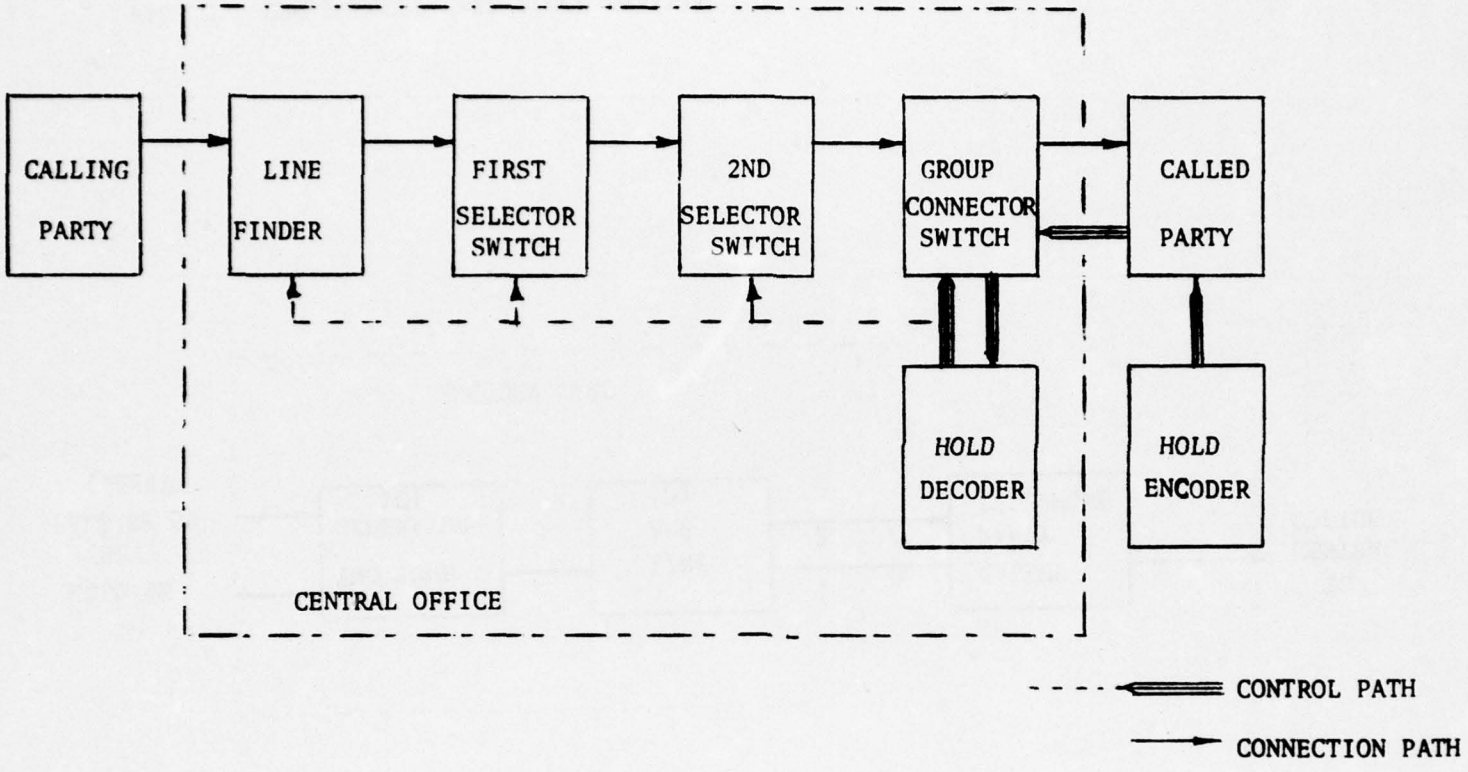

FIG. 1. PATH CONNECTION IN A TELEPHONE CIRCUIT. THIS SHOWS HOW A CALL IS CONNECTED IN A CENTRAL OFFICE (4 DIGIT DIALING) FROM A "CALLING" TO A "CALLED" PARTY, AND CONTROL PATH FOR A "CALLED PARTY HOLD (CPH)" DEVICE.

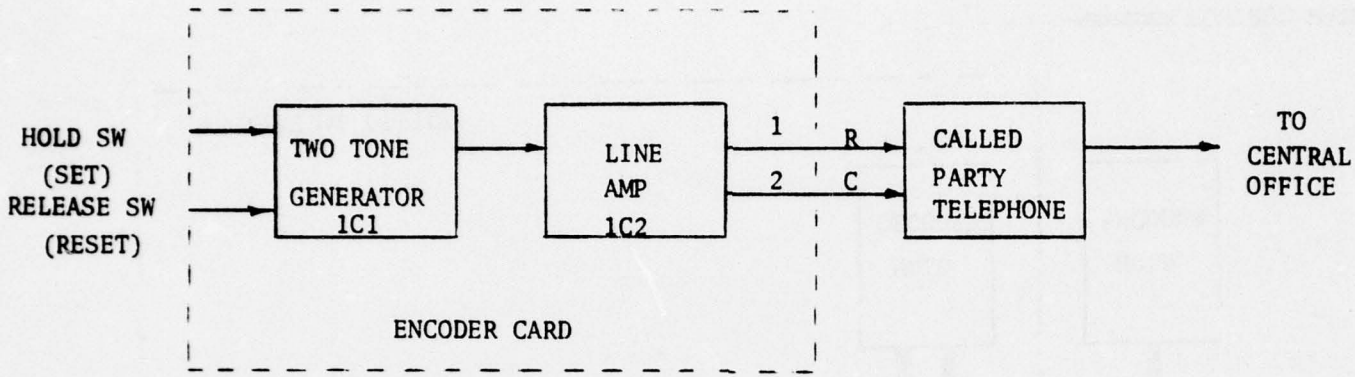

FIG. 2. CPH ENCODER CARD BLOCK DIAGRAM

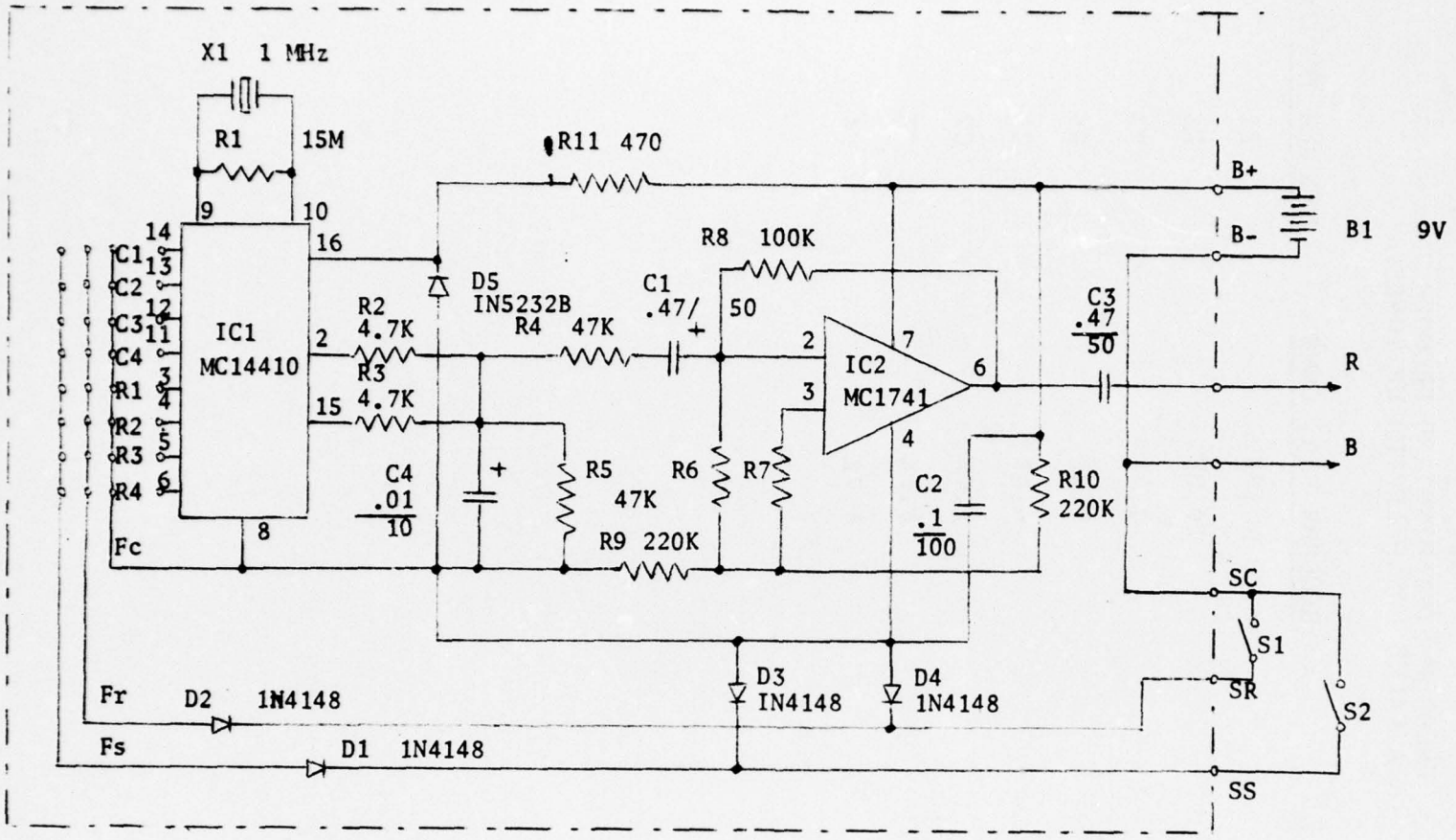

Figure 3. Called Party Hold Encoder. Schematic diagram showing strap - selectable tone output Fc (common), Fr (reset), Fs (Set).

TABLE 1
ENCODER STRAPPING AND DECODER
R1A VALUE FOR SELECTED MF TONES

FREQUENCY HZ	DECODER R1A, OHMS	ENCODER TERMINAL
697	12.0K	R1
770	10.0K	R2
852	9.2K	R3
941	9.2K	R4
1209	6.8K	C1
1336	5.6K	C2
1447	4.7K	C3
1633	4.7K	C4

Figure 4 shows the decoder block diagram and interface connections at the DCO connector group shelf. Figure 5 shows the prototype decoder electrical circuit. Table 1 shows R1A values for selected tone frequencies. The decoder was packaged into a 4" x 4" x 1-1/2" aluminum box in order to fit existing SxS connector shelf mounting space. It also uses DCO -48VDC, 50 ma/decoder battery power.

The decoder electrical operations can be analyzed using Figures 4 and 5. During initial power connection, the decoder will come up on the "release" condition as capacitor C12 will force 1C3-C to go low. The circuit will then remain idle until the proper tone combination is sensed across T-R. For the prototype, 1209 Hz and 941 Hz tones will cause 1C1A and 1C1B outputs to go low, causing 1C3-C latch to a high output. This will turn on Q1 and operate K1. K1, in the "on" condition, will short the "C" lead to ground, holding the switch train.

The decoder will reset when a 941 Hz and 1477 Hz tone combination is received, or when the local reset switch is depressed.

2.3 Test Characteristics. Two encoder units and four decoder units were fabricated and tested by the AFCS Prototype Test Facility. An unpackaged encoder/decoder set was also tested at the Scott AFB DCO on 10 December 1975. The results of these tests are shown in Table 2, and can be summarized as follows:

a. Decoder:

(1) Sensitivity: 30 dBm minimum.

(2) Phase locked loop bandwidth: $f_o \pm 8\%$ max.

(3) Power: -42 to-64VDC, 20 ma (idle), 47 ma (hold).

(4) Temperature rise: +18°C maximum.

(5) Impedance: 5000 ohms, minimum.

(6) Size: 4" x 4" x 1-1/2", may be reduced to 3.8" x 3.6" x 1.5".

(7) Number required: One per group connector switch.

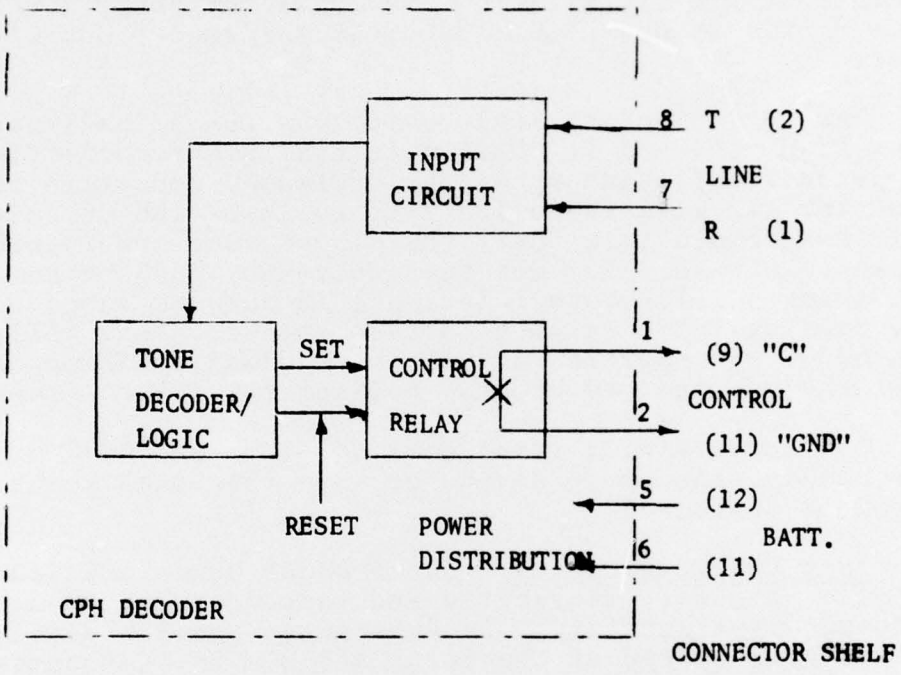

FIG. 4. DECODER CARD BLOCK DIAGRAM AND INTERFACE CONNECTIONS

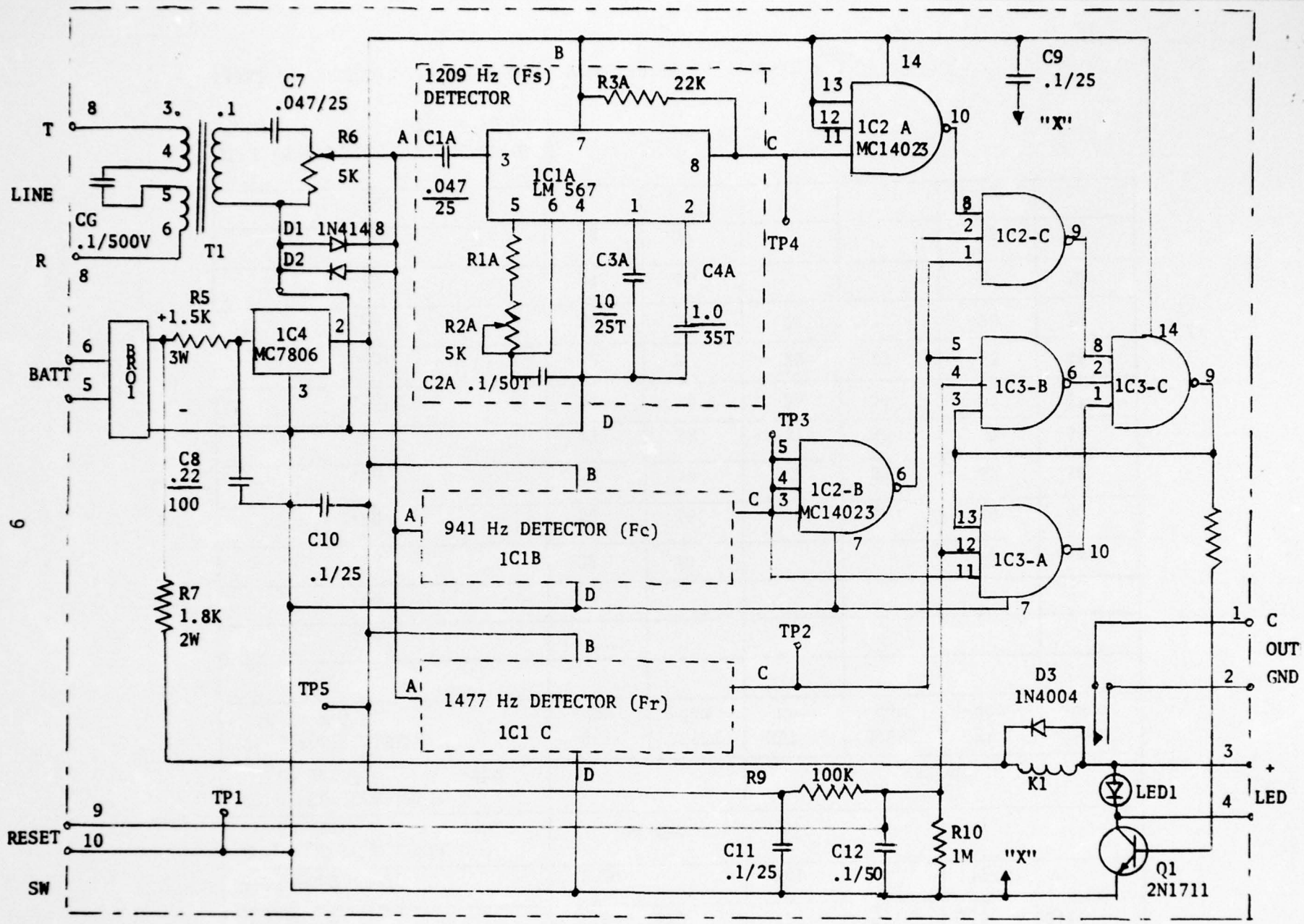

FIG 5. CPH DECODER SCHEMATIC DIAGRAM

NOTE: Resistances in ohms/1/4W, 5%; capacitances in microfarads/volts, unless otherwise specified.

PLL NUMBER	1C1 A		1C1 B		1C1 C	
ADJ RANGE, HZ	938 - 1612		787 - 1235		1168 - 2241	
REST FREQ (F_C), HZ	1209		941		1477	
COMBINED TONE LEVEL TO SET -dbm	-34 dbm					
COMBINED TONE LEVEL TO RESET -dbm			-32 dbm			
TEST TONE LEVEL @ (F_T - F_C) HZ	SET -dbm	RESET -dbm	SET -dbm	RESET -dbm	SET -dbm	RESET -dbm
+120						
+100						
+80						
+60	29	30			22	33
+40	30	36	26	33	30	36
+20	37	38	35	38	37	38
0	37	38	37	38	37	38
-20	35	36	33	34	36	37
-40	32	33	29	30	33	34
-60	30	31	26	27	26	30
-80	27	28			29	30
-100	25	26			16	27
-120					12	26

TEST CONDITIONS: Vcc = 50VOLTS
T_a = 20 C

TABLE 2. DECODER RESPONSE AND CHARACTERISTICS. UNIT # 1.

PLL NUMBER	1C1 A		1C1 B		1C1 C	
ADJ RANGE, HZ	1028 - 1967		775 - 1217		1028 - 1967	
REST FREQ (F_C), HZ	1209		941		1477	
COMBINED TONE LEVEL TO SET -dbm	-28 dbm					
COMBINED TONE LEVEL TO RESET -dbm			28			
TEST TONE LEVEL @ (F_T - F_C) HZ -dbm	SET -dbm	RESET -dbm	SET -dbm	RESET -dbm	SET -dbm	RESET -dbm
+120						
+100	9	18				
+80	15	27			16	28
+60	22	30	15	17	23	31
+40	31	33	24	27	32	33
+20	34	36	32	34	34	35
0	35	36	33	36	34	36
-20	32	34	30	31	33	34
-40	30	31	23	25	30	31
-60	28	29			27	29
-80	24	25			26	27
-100					23	24
-120						

TEST CONDITIONS: Vcc = 50VOLTS

T_a = 20 C

TABLE 2. DECODER RESPONSE AND CHARACTERISTICS. UNIT # 2 .

PLL NUMBER	1C1 A		1C1 B		1C1 C	
ADJ RANGE, HZ	971 - 1658		796 - 1258		1067 - 2056	
REST FREQ (F_C), HZ	1209		941			
COMBINED TONE LEVEL TO SET -dbm	-30 dbm				- 1477	
COMBINED TONE LEVEL TO RESET -dbm	-		-30 dbm			
TEST TONE LEVEL @ (F_T - F_C) HZ	SET -dbm	RESET -dbm	SET -dbm	RESET -dbm	SET -dbm	RESET -dbm
+120						
+100					25	26
+80	15	27			27	29
+60	21	31	18	27	24	31
+40	33	35	31	32	32	33
+20	37	38	35	37	35	36
0	36	38	37	38	36	38
-20	34	35	33	34	36	38
-40	31	32	29	30	33	35
-60	29	30	25	26	23	32
-80	28	29			17	29
-100	25	26				
-120						

TEST CONDITIONS: Vcc = 50VOLTS

T_a = 20 C

TABLE 2. DECODER RESPONSE AND CHARACTERISTICS. UNIT # 3 .

PLL NUMBER	1C1 A		1C1 B		1C1 C	
ADJ RANGE, HZ	921 - 1570		874 - 1371		-	
REST FREQ (F_C), HZ	1209		941			
COMBINED TONE LEVEL TO SET -dbm	32				-1477	
COMBINED TONE LEVEL TO RESET -dbm	-		32			
TEST TONE LEVEL @ (F_T - F_C) HZ -dbm	SET -dbm	RESET -dbm	SET -dbm	RESET -dbm	SET -dbm	RESET -dbm
+120						
+100					8	27
+80					17	30
+60	22	30			23	35
+40	34	36	26	34	36	38
+20	37	39	35	37	38	40
0	38	40	36	38	38	41
-20	36	37	33	34	36	38
-40	33	34	24	30	34	35
-60	21	30	25	26	24	30
-80	27	28			29	30
-100					27	28
-120						

TEST CONDITIONS: Vcc = 50VOLTS

T_a = 20 C

TABLE 2. DECODER RESPONSE AND CHARACTERISTICS. UNIT #4 .

b. Encoder

(1) Output tones: Standard M-F tones, selectable, -11 dBm, single tone to 600 ohms; -8 dBm, M-F composite output.

(2) Power: 9VDC, 10 ma maximum.

(3) Size: 4" x 2.5" x 1.5".

(4) Operating Temperature: 0°C - 50°C.

(5) Number required: One per subscriber telephone set.

3. SUMMARY AND RECOMMENDATION

3.1 Summary. The CPH device described will minimize AUTOVON interface problems as it operates on a highly selective basis when installed on an SxS DCO. Although it will equip the same number of group connector switches as the AT&T T41-S device, only telephones with encoders can activate the decoders. This eliminates unwanted CPH features on non-critical numbers and reduces the CPH interference to a minimum on CPH equipped subscribers. Additionally, the subscriber can release the line without having to hang up if "CPH" is not required.

3.2 Recommendation. This device is adaptable to Air Force wide use when fully developed; tests indicate successful functional operation. However, before complete procurement specifications are written, the device will be subjected to extensive field tests at the Scott AFB government-owned SxS DCO for a 90-day period. Twenty decoders and at least one encoder will be fabricated to equip one group of connector switches and one telephone number for these field tests.

Any significant design changes developed as a result of the field tests will be documented in the test report which will be issued as a supplement to this study report.

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