

## REMOTE CONTROL TRANSMITTER

ADVANCE DATA

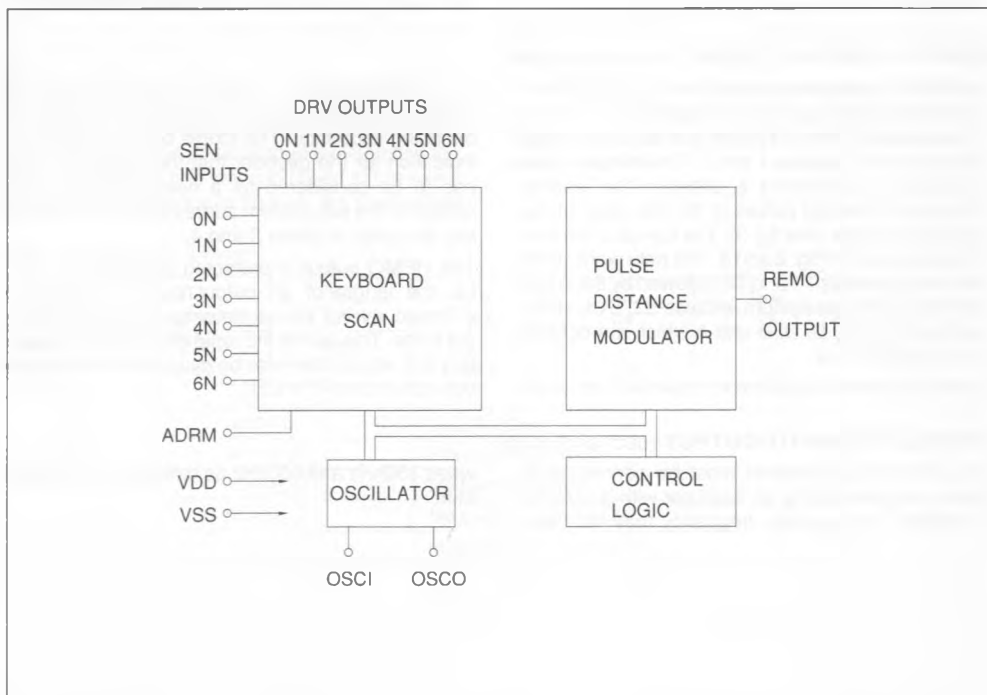
- FLASHED OR MODULATED TRANSMISSION
- 7 SUB-SYSTEM ADDRESSES
- UP TO 64 COMMANDS PER SUB-SYSTEM ADDRESS
- HIGH-CURRENT REMOTE OUTPUT AT  $V_{DD} = 6V$  ( $-I_{OH} = 120mA$ )
- LOW NUMBER OF ADDITIONAL COMPONENTS
- KEY RELEASE DETECTION BY TOGGLE BITS
- VERY LOW STAND-BY CURRENT ( $< 2\mu A$ )
- OPERATIONAL CURRENT  $< 1mA$  AT 6V SUPPLY
- SUPPLY VOLTAGE RANGE 2 TO 6.5V
- CERAMIC RESONATOR CONTROLLED FREQUENCY (typ. 450kHz)
- ENCAPSULATION : 20-LEAD PLASTIC DIL

### DESCRIPTION

The M3004 LAB1 transmitter IC is designed for infrared remote control systems. It has a total of 448 commands which are divided into 7 sub-system groups with 64 commands each. The sub-system code may be selected by a press button, a slider switch or hard wired.

The M3004 LAB1 generates the pattern for driving the output stage. These patterns are pulse distance coded. The pulses are infrared flashes or modulated. The transmission mode is defined in conjunction with the sub-system address. Modulated pulses allow receivers with narrow-band preamplifiers for improved noise rejection to be used. Flashed pulses require a wide-band preamplifier within the receiver.

### BLOCK DIAGRAM



## INPUTS AND OUTPUTS

Key matrix inputs and outputs (DRV0N to DRV6N and SEN0N to SEN6N).

The transmitter keyboard is arranged as a scanned matrix. The matrix consists of 7 driver outputs and 7 sense inputs as shown in fig. 1. The driver outputs DRV0N to DRV6N are open drain N-channel transistors and they are conductive in the stand-by

### ADDRESS MODE INPUT (ADRM)

The sub-system address and the transmission mode are defined by connecting the ADRM input to one or more driver outputs (DRV0N to DRV6N) of the key matrix. If more than one driver is connected to ADRM, they must be decoupled by diodes. This allows the definition of seven sub-system addresses as shown in table 3. If driver DRV6N is connected to ADRM, the data output format of REMO is modulated or if not connected, flashed.

The ADRM input has switched pull-up and pull-down loads. In the stand-by mode, only the pull-down device is active. Whether ADRM is open (sub-system address 0, flashed mode) or connected to the driver outputs, this input is LOW and will not cause unwanted dissipation. When the transmitter becomes active by pressing a key, the pull-down de-

### REMOTE CONTROL SIGNAL OUTPUT (REMO)

The REMO signal output stage is a push-pull type. In the HIGH state, a bipolar emitter-follower allows a high output current. The timing of the data output format is listed in tables 1 and 2. The information is defined by the distance  $t_b$  between the leading edges of the flashed pulses or the first edge of the modulated pulses (see fig. 3). The format of the output data is given in fig. 2 and 3. The data word starts with two toggle bits T1 and T0, followed by three bits for defining the sub-system address S2, S1 and S0, and six bits F, E, D, C, B and A which are defined by the selected key.

In the modulated transmission mode the first toggle

### OSCILLATOR INPUT/OUTPUT (osci and osco)

The external components must be connected to these pins when using an oscillator with a ceramic resonator. The oscillator frequency may vary bet-

mode. The 7 sense inputs (SEN0N to SEN6N) enable the generation of 56 command codes. With 2 external diodes all 64 commands are addressable. The sense inputs have P-channel pull-up transistors so that they are HIGH until they are pulled LOW by connecting them to an output via a key depression to initiate a code transmission.

vice is switched off and the pull-up device is switched on, so that the applied driver signals are sensed for the decoding of the sub-system address and the mode of transmission.

The arrangement of the sub-system address coding is such that only the driver DRVnM with the highest number (n) defines the sub-system address, e.g. if drivers DRV2N and DRV4N are connected to ADRM, only DRV4N will define the sub-system address. This option can be used in systems requiring more than one sub-system address. The transmitter may be hard-wired for sub-system address 2 by connecting DRV1N to ADRM. If now DRV3N is added to ADRM by a key or a switch, the transmitted sub-system address changes to 4. A change of the sub-system address will not start a transmission.

bit is replaced by a constant reference time bit (REF). This can be used as a reference time for the decoding sequence. The toggle bits function as an indication for the decoder that the next instruction has to be considered as a new command. The codes for the sub-system address and the selected key are given in tables 3 and 4.

The REMO output is protected against "Lock-up", i.e. the length of an output pulse is limited to < 1msec, even if the oscillator stops during an output pulse. This avoids the rapid discharge of the battery that would otherwise be caused by the continuous activation of the LED.

ween 350kHz and 600kHz as defined by the resonator.

## FUNCTIONAL DESCRIPTION

### Keyboard operation.

In the stand-by mode all drivers (DRV0N to DRV6N) are on (low impedance to  $V_{SS}$ ). Whenever a key is pressed, one or more of the sense inputs (SENnN) are tied to ground. This will start the power-up sequence. First the oscillator is activated and after the debounce time  $t_{DB}$  (see fig. 4) the output drivers (DRV0N to DRV6N) become active successively).

Within the first scan cycle the transmission mode, the applied sub-system address and the selected

command code are sensed and loaded into an internal data latch.

In contrast to the command code, the sub-system is sensed only within the first scan cycle. If the applied sub-system address is changed while the command key is pressed, the transmitted sub-system address is not altered.

In a multiple key stroke sequence (see fig. 5) the command code is always altered in accordance with the sensed key.

## MULTIPLE KEY-STROKE PROTECTION

The keyboard is protected against multiple key-strokes. If more than one key is pressed at the same time, the circuit will not generate a new output at REMO (see fig. 5). In case of a multiple key-stroke, the scan repetition rate is increased to detect the release of a key as soon as possible.

There are two restrictions caused by the special structure of the keyboard matrix :

- The keys switching to ground (code numbers 7, 15, 23, 31, 39, 47, 55 and 63) and the keys con-

nected to SEN5N and SEN6N are not covered completely by the multiple key protection. If one sense input is switched to ground, further keys on the same sense line are ignored, i.e. the command code corresponding to "key to ground" is transmitted.

- SEN5N and SEN6N are not protected against multiple keystroke on the same driver line, because this condition has been used for the definition of additional codes (code number 56 to 63).

## OUTPUT SEQUENCE (data format)

The output operation will start when the selected code is found. A burst of pulses, including the latched address and command codes, is generated at the output REMO as long as a key is pressed. The format of the output pulse train is given in fig. 2 and 3. The operation is terminated by releasing the key or if more than one key is pressed at the same time. Once a sequence is started, the transmitted

data words will always be completed after the key is released.

The toggle bits T0 and T1 are incremented if the key is released for a minimum time  $t_{REL}$  (see fig. 4). The toggle bits remain unchanged within a multiple key-stroke sequence.

**Table 1:** Pulse train Timing.

Mode	$T_o$ ms	$t_p$ $\mu s$	$t_M$ $\mu s$	$t_{ML}$ $\mu s$	$t_{MH}$ $\mu s$	$t_w$ ms
Flashed	2.53	8.8	–	–	–	121
Modulated	2.53	–	26.4	17.6	8.8	121

$f_{OSC}$	455kHz	$t_{OSC} = 2.2\mu s$
$t_p$	$4 \times t_{OSC}$	Flashed Pulse Width
$t_M$	$12 \times t_{OSC}$	Modulation Period
$t_{ML}$	$8 \times t_{OSC}$	Modulation Period LOW
$t_{MH}$	$4 \times t_{OSC}$	Modulation Period HIGH
$T_o$	$1152 \times t_{OSC}$	Basic Unit of Pulse Distance
$t_w$	$5529 \times t_{OSC}$	Word Distance

**Table 2 :** Pulse Train Separation ( $t_b$ ).

Code	$t_b$
Logic "0"	$2 \times T_o$
Logic "1"	$3 \times T_o$
Toggle Bit Time	$2 \times T_o$ or $3 \times T_o$
Reference Time	$3 \times T_o$

**Table 3 :** Transmission mode and sub-system address selection.

The sub-system address and the transmission mode are defined by connecting the ADRM input to one or more driver outputs (DRV0N to DRV6N) of the key matrix. If more than one driver is connected to ADRM, they must be decoupled by diodes.

Mode	Sub-system Address				Driver DRVnN for n =						
	#	S2	S1	S0	0	1	2	3	4	5	6
F	0	1	1	1							
L	1	0	0	0	O						
A	2	0	0	1	X						
S	3	0	1	0	X	X	O				
H	4	0	1	1	X	X	X	O			
E	5	1	0	0	X	X	X	X	O		
D	6	1	0	1	X	X	X	X	X	O	
M	0	1	1	1							O
D	1	0	0	0	O						O
U	2	0	0	1	X	O					O
L	3	0	1	0	X	X	O				O
A	4	0	1	1	X	X	X				O
T	5	1	0	0	X	X	X	O	O		O
E	6	1	0	1	X	X	X	X	X	O	O
D											O

O = connected to ADRM  
 blank = not connected to ADRM  
 X = don't care.

Table 4 : Key Codes.

Matrix Drive	Matrix Sense	Code						Matrix Position
		F	E	D	C	B	A	
DRV0N	SEN0N	0	0	0	0	0	0	0
DRV1N	SEN0N	0	0	0	0	0	1	1
DRV2N	SEN0N	0	0	0	0	1	0	2
DRV3N	SEN0N	0	0	0	0	1	1	3
DRV4N	SEN0N	0	0	0	1	0	0	4
DRV5N	SEN0N	0	0	0	1	0	1	5
DRV6N	SEN0N	0	0	0	1	1	0	6
VSS	SEN0N	0	0	0	1	1	1	7
VSS	SEN1N	0	0	1	1	1	1	8 to 15
VSS	SEN2N	0	1	0	1	1	1	16 to 23
VSS	SEN3N	0	1	1	1	1	1	24 to 31
VSS	SEN4N	1	0	0	1	1	1	32 to 39
VSS	SEN5N	1	0	1	1	1	1	40 to 47
VSS	SEN6N	1	1	0	1	1	1	48 to 55
VSS	SEN5N and SEN6N	1	1	1	1	1	1	56 to 63

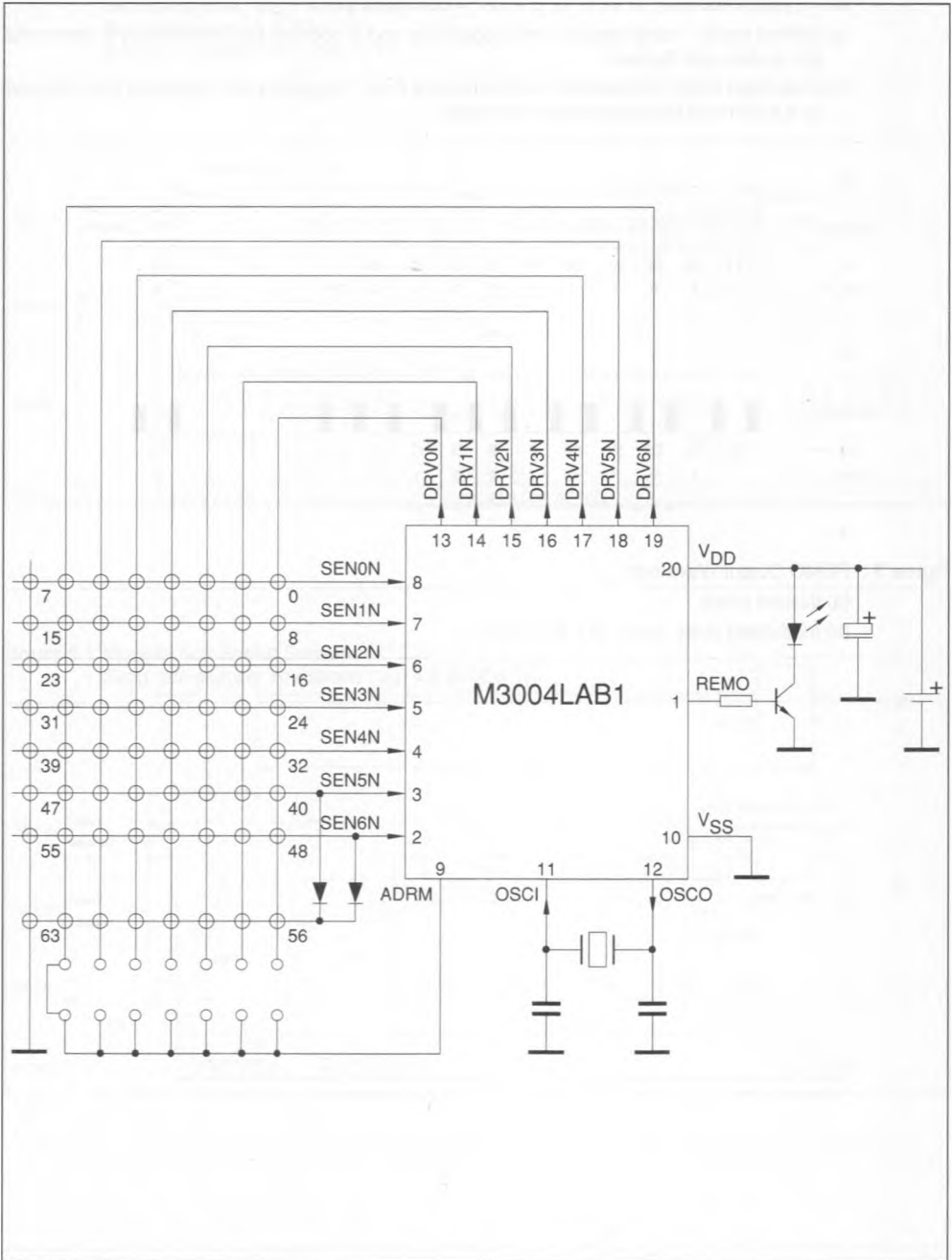
## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{DD}$	Supply Voltage Range	- 0.3 to + 7	V
$V_I$	Input Voltage Range	- 0.3 to ( $V_{DD} + 0.3$ )	V
$V_O$	Output Voltage Range	- 0.3 to ( $V_{DD} + 0.3$ )	V
$\pm I$	D. C. Current into Any Input or Output	Max. 10	mA
$-I(\text{REMO})M$	Peak REMO Output Current during 10 $\mu$ s ; Duty Factor = 1%	Max. 300	mA
$P_{tot}$	Power Dissipation per Package for $T_{amb} = - 20$ to + 70°C	Max. 200	mW
$T_{stg}$	Storage Temperature Range	- 55 to + 125	°C
$T_{amb}$	Operating Ambient Temperature Range	- 20 to + 70	°C

ELECTRICAL CHARACTERISTICS  $V_{SS} = 0V$  ;  $T_{amb} = 25^{\circ}C$  ; unless otherwise specified

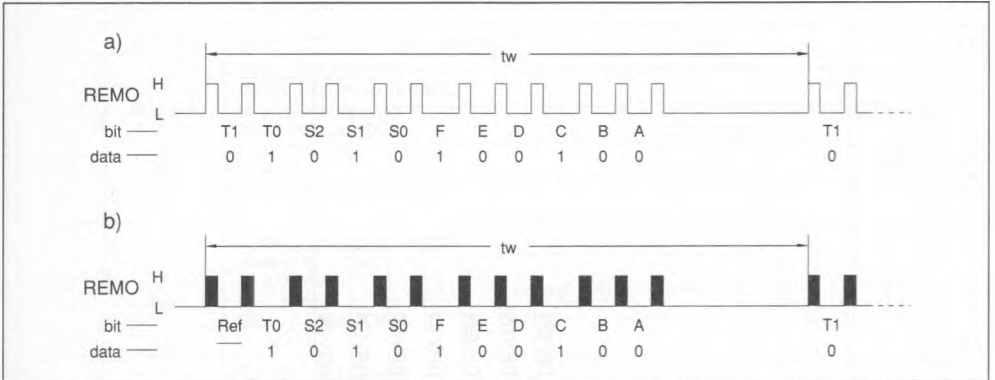
Symbol	$V_{DD}(V)$	Parameter	Min.	Typ.	Max.	Unit
$V_{DD}$		Supply Voltage $T_{amb} = 0$ to $+70^{\circ}C$	2		6.5	V
$I_{DD}$ $I_{DD}$	3 6	Supply Current ; Act. $f_{OSC} = 455kHz$ ; REMO Outp. Unload.		0.25 1.0		mA mA
$I_{DD}$	6	Supply Current ; Inactive (stand-by mode) $T_{amb} = 25^{\circ}C$			4	$\mu A$
fosc	2 to 6.5	Oscill. Frequency (cer. resonator)	350		600	kHz
$V_{IL}$ $V_{IH}$ $-I_I$ $-I_I$ $I_I$	2 to 6.5 4 to 11 2 6.5 6.5	<u>Keyboard Matrix</u> Inputs SEN0N to SEN6N Input Voltage LOW Input Voltage HIGH Input Current $V_I = 0V$ Input Leakage Current $V_I = V_{DD}$	$0.7 \times V_{DD}$ 10 100		$0.3 \times V_{DD}$ 100 600 1	V V $\mu A$ $\mu A$ $\mu A$
$V_{OL}$ $V_{OL}$ $I_O$	2 6.5 6.5	<u>Outputs DRV0N to DRV6N</u> Output Volt. "ON" $I_O = 0.1mA$ $I_O = 1.0mA$ Outp. Current "OFF" $V_O = 11V$			0.3 0.6 10	V V $\mu A$
$V_{IL}$ $V_{IH}$ $I_{IL}$ $I_{IL}$ $I_{IH}$ $I_{IH}$	  2 6.5 2 6.5	<u>Control Input ADRM</u> Input Voltage LOW Input Volt. HIGH Input Current (switched P-and N-channel pull-up/pull-down) Pull-up Act., Oper. Condition ; $V_{IN} = V_{SS}$ Pull-down Active Standby Cond. ; $V_{IN} = V_{DD}$	$0.7 \times V_{DD}$  10 100 10 100		$0.3 \times V_{DD}$  100 600 100 600	V V $\mu A$ $\mu A$ $\mu A$ $\mu A$
$V_{OH}$ $V_{OH}$ $V_{OL}$ $V_{OL}$ $t_{OH}$	2 6.5 2 6.5 6.5	<u>Data Output REMO</u> Output Volt. HIGH $-I_{OH} = 40mA$ Output Volt. LOW $I_{OL} = 0.3mA$ Pulse Length, Oscill. Stopped	0.8 5.0		0.4 0.4 1	V V V ms
$I_I$ $I_I$ $V_{OH}$ $V_{OL}$	2 6.5 6.5 6.5	<u>Oscillator</u> Input Current OSC1 at $V_{DD}$ Output Volt. HIGH $-I_{OL} = 0.1mA$ Output Volt. LOW $I_{OH} = 0.1mA$	5.0  $V_{DD} - 0.8$		5.0 7.0  0.7	$\mu A$ $\mu A$ V V

Figure 1 : Typical Application.



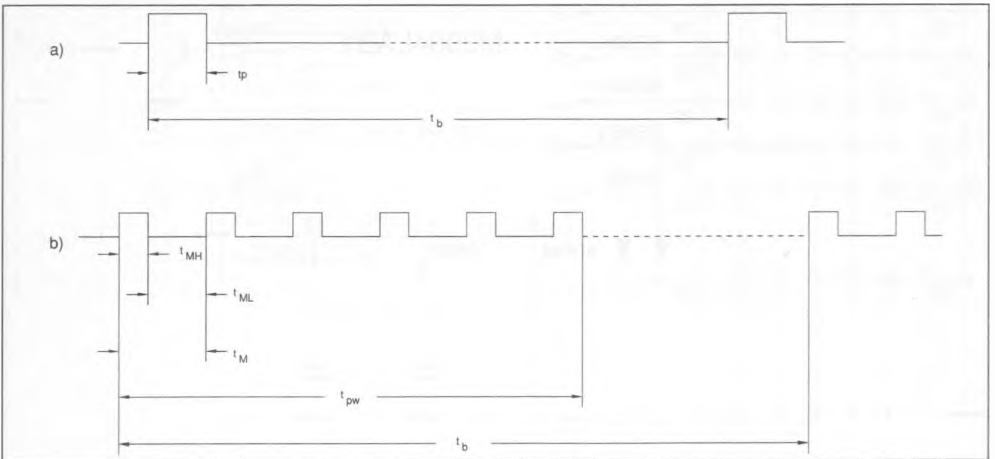
**Figure 2 :** Data Format of REMO Output ; REF = Reference Time ; T0 and T1 = Toggle bits ; S0, S1 and S2 = system Address ; A, B, C, D, E and F = command bits.

- (a) flashed mode : transmission with 2 toggle bits and 3 address bits, followed by 6 command bits (pulses are flashed)
- (b) modulated mode : transmission with reference time, 1 toggle bit and 3 address bits, followed by 6 command bits (pulses are modulated).



**Figure 3 :** REMO Output Waveform.

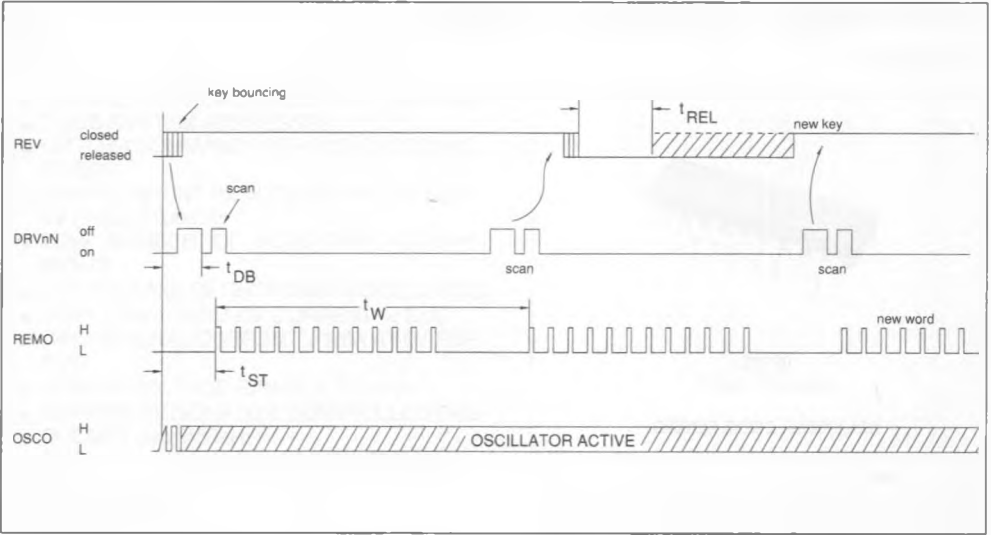
- (a) flashed pulse.
- (b) modulated pulse { $t_{pw} = (5 \times t_M) + t_{MH}$ }





**Figure 4 : Single Key - Stroke Sequence.**

Debounce time :  $t_{DB} = 4$  to  $9 \times T_O$   
 Start time :  $t_{ST} = 5$  to  $10 \times T_O$   
 Minimum release time :  $t_{REL} = T_O$ .



**Figure 5 : Multiple Key-Stroke Sequence.**

Scan rate multiple key-stroke :  $t_{SM} = 8$  to  $10 \times T_O$ .

