## PRODUCT NAME
TR1001

TITLE
I. The relationship between the values of programmable counter and the frequency of radio stations.

II. The flow chart that shows the steps of searching radio stations within reception range.

III. Using LD signals to tell whether a radio station has been successfully locked down.

**IV.** Lowering the power consumption of MCU when shutting down the power of TR1001.

APPLICATION NOTE
I. The relationship between the values of programmable counter and the frequency of radio stations:

1. The voltage range for the operation of TR1001 is VDD = 2.4V~3.6V, and the crystal within the range of 1MHz ~ 12MHz can be used.

2. The frequency of the radio stations can be configured to within the range between 87.5 MHz to 108.0 MHz, and the interval in the frequency of the radio stations is 0.1 MHz, so a total of 206 radio stations can be configured. (The actual operational frequency of TR1001 is between 87.45 MHz to 107.95 MHz. For the conversion of operational frequency, please refer to [**5.** Instruction on the configuration of the programmable counter]).

3. For the radio frequency between 87.5 MHz to 108.0 MHz, the range of programmable counter that needs to be configured is 17490 ~ 21590, when the frequency interval is ±0.1MHz, the variation value for the programmable counter is ±20. An example is provided below:
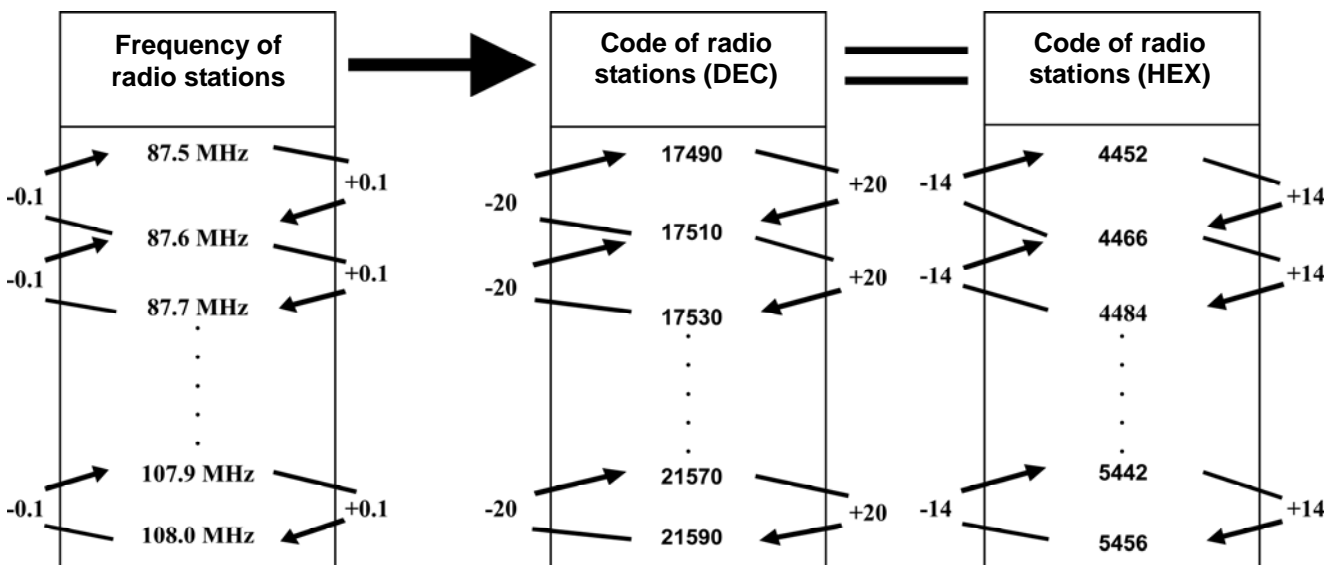
4. Serial data transfer format：
Using the serial I/O of TR1001 to transfer the values of programmable counter.
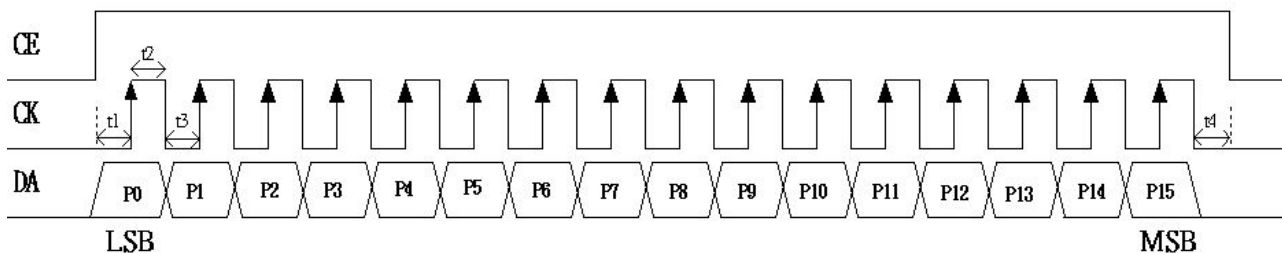
(1). CE signal: The period of time from the beginning of signals (rising) to the end of signals (falling) must include 16 CK clock.
(2). CK signal: DA signals will latch into TR1001 at the CK rising edge.
(3). DA signal: When sending the values of programmable counter, it needs to start from LSB.
(4). t1, t2, t3, t4 time: > 4us
(5). After completing the sending of 16 bits data, the signals of CE, CK, and DA must be kept at the low status.

5. How to calculate the configurable values of programmable counter:
[P15…...P0] =N (the configurable value of programmable counter:
1600(dec) < N < 65280 (dec))

For example:
If   N=17490;
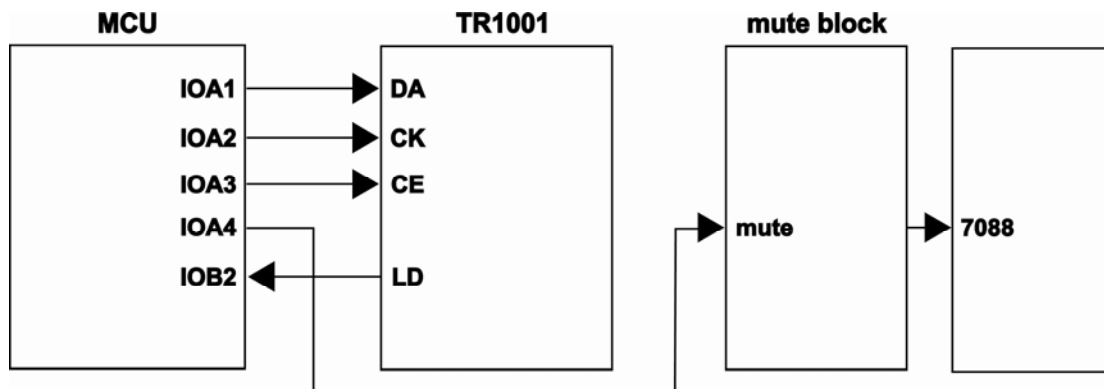Crystal frequency = 4MHz;
Reference frequency = 4MHz/800(fixed) = 5kHz.
Synthesis frequency f = 5kHz $\times$ N=5kHz $\times$ 17490 = 87.45MHz

Note:
In the application of TR1001 + 7088, the intermediate frequency we used is
F_{if} = 87.5MHz $-$ 87.45MHz = 50KHz

6. Hardware: (as the diagram shown below)
MCU is used to control TR1001 in order to gain further control of 7088 tuner IC.

7. In the example of programming shown below, the 4 bit MCU of tenx technology inc. is utilized to control TR1001 in locking down the radio frequency at 87.5 MHz [4452(hex)] (using the IOA port to transfer CE, CK, and DA signals, while also defining IOA3=CE, IOA2=CK and IOA1=DA)

```
.data
            data0     equ   00h        ;defining four registers, which are
                                        data0~data3, for saving the code of radio
                                        stations
            data1     equ   01h        ;data3 is MSB ; data0 is LSB
            data2     equ   02h
            data3     equ   03h

            serial_signal   equ   04h  ;defining the transfer of CE, CK, DA signals
            data_times      equ   05h
            data_buff 0     equ   06h
            data_buff 1     equ   07h
            .endd
.code
Start:
            lds   data0 , 02H          ;initializing data0~data3(4452)
            lds   data1 , 05H
            lds   data2 , 04H
            lds   data3 , 04H

            lds   serial_signal, 00h   ;initializing CE=0, CK=0, DA=0, and send out
                                        signals from IOA port
            opa   serial_signal,
            spa   1fh

            lds   70H, 00h             ;moving the content of data0 register to the
                                        data_buff0 register
            mvl   70H
            mvh   71H
            mvu   70H
            lda#  @hl
            sta   data_buff0
            lds   data_times,04H       ;code data total 16 bit
            lds   data_buff1,04H       ;set data_times  *data_buff1=16
            call   send_clk
.endc
;********************************************************************************
send_clk:                              ;the send_clk subroutine function sends out
                                        the content of data0~data3 registers from
                                        IOA port in the method of serial mode.
send_clk0:
            lda     data_buff0
            jb0     send_clk1
            lds     serial_signal,04h
```

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```
                opa     serial_signal
                lds     serial_signal,06h
                jmp     send_clk2
send_clk1：
                lds     serial_signal,05h
                opa     serial_signal
                lds     serial_signal,07h
                nop
send_clk2：
                dec*  data_buff1
                jz      send_clk3
                nop
                nop
                nop
                opa      serial_signal
                sr0      data_buff0
                nop
                nop
                jmp     send_clk0
send_clk3：
                lds     data_buff1,04h
                dec*    data_times
                jz      send_clk4
                opa     serial_signal
                lda#    @hl
                sta      data_buff0
                nop
                jmp     send_clk0
send_clk4：
                opa      serial_signal
                nop
                nop
                nop
                nop
                nop
                nop
                lds     70h,04h
                opa     70h
                nop
                nop
                nop
                nop
                nop
                nop
                lds     70h,00h
                opa     70h
                rts
```

II. The flow chart that shows the steps of searching radio stations within reception range.

    1. The flow chart of the automatic scanning mode (it is recommended to start scanning frequency from 87.5MHz and continues upwards until it reaches 108.0MHz):
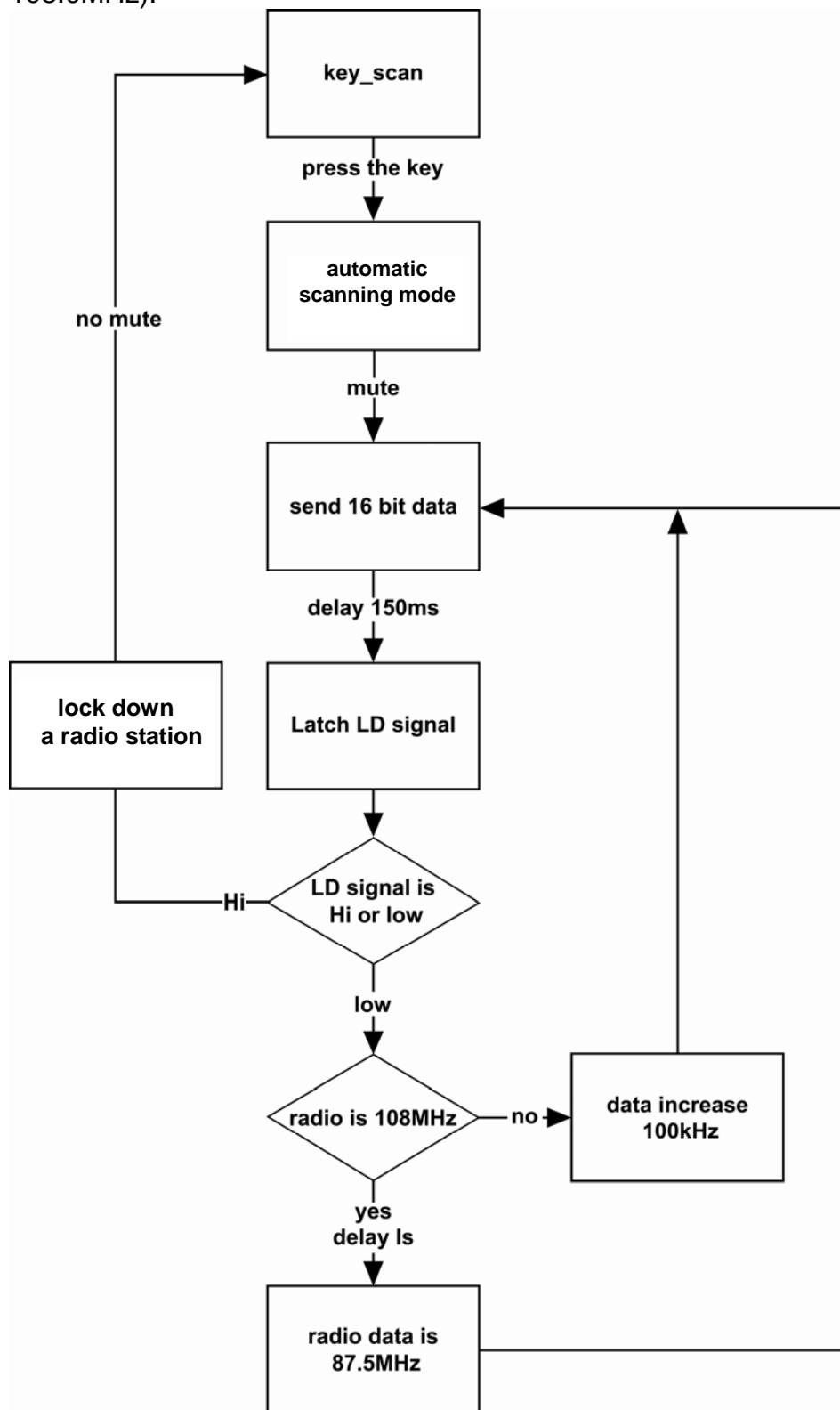
```
                        ┌──────────────┐
           ┌───────────▶│   key_scan   │
           │            └──────┬───────┘
           │              press the key
           │                   │
           │                   ▼
           │            ┌──────────────┐
           │            │  automatic   │
   no mute │            │ scanning mode│
           │            └──────┬───────┘
           │                 mute
           │                   │
           │                   ▼
           │            ┌──────────────┐
           │            │ send 16 bit  │◀────────┐
           │            │    data      │         │
           │            └──────┬───────┘         │
           │              delay 150ms            │
           │                   │                 │
  ┌────────┴───────┐           ▼                 │
  │   lock down    │    ┌──────────────┐         │
  │ a radio station│    │ Latch LD     │         │
  │                │    │   signal     │         │
  └────────────────┘    └──────┬───────┘         │
           │                   │                 │
           │                   ▼                 │
           │              ╱─────────╲            │
           └────Hi────────  LD signal│           │
                          ╲ Hi or low╱           │
                           ╲─────────╱           │
                               low               │
                                │                │
                                ▼                │
                          ╱──────────╲    ┌──────────────┐
                          ╲radio is  ╱─no─▶│data increase │
                          ╱108MHz    ╲    │   100kHz     │
                          ╲──────────╱    └──────────────┘
                               yes
                             delay ls
                                │
                                ▼
                          ┌──────────────┐
                          │ radio data is│
                          │   87.5MHz    │
                          └──────────────┘
```

2. The flow chart that shows the steps of searching radio stations within reception range:

```
                        ┌──────────────┐
             ┌─────────>│   key_scan   │<──────────┐
             │          └──────────────┘           │
             │                 │                    │
             │          press the button           │
             │                 ▼                    │
             │          ┌──────────────┐            │
             │          │   manual     │            │
             │          │  searching   │            │
             │          │    mode      │            │
             │          └──────────────┘            │
             │                 │                    │
             │               mute                   │
             │                 ▼                    │
          no mute      ┌──────────────┐           mute
             │          │send 16 bit   │            │
             │          │    data      │            │
             │          └──────────────┘            │
             │                 │                    │
             │           delay 100 ms               │
             │                 ▼                    │
             │          ┌──────────────┐            │
             │          │Latch LD signal│           │
             │          └──────────────┘            │
             │                 │                    │
             │                 ▼                    │
             │           ╱───────────╲              │
             │    < 3   ╱  LD signal   ╲   > = 3    │
             └─────────╱  change times  ╲───────────┘
                       ╲                ╱
                        ╲──────────────╱
```

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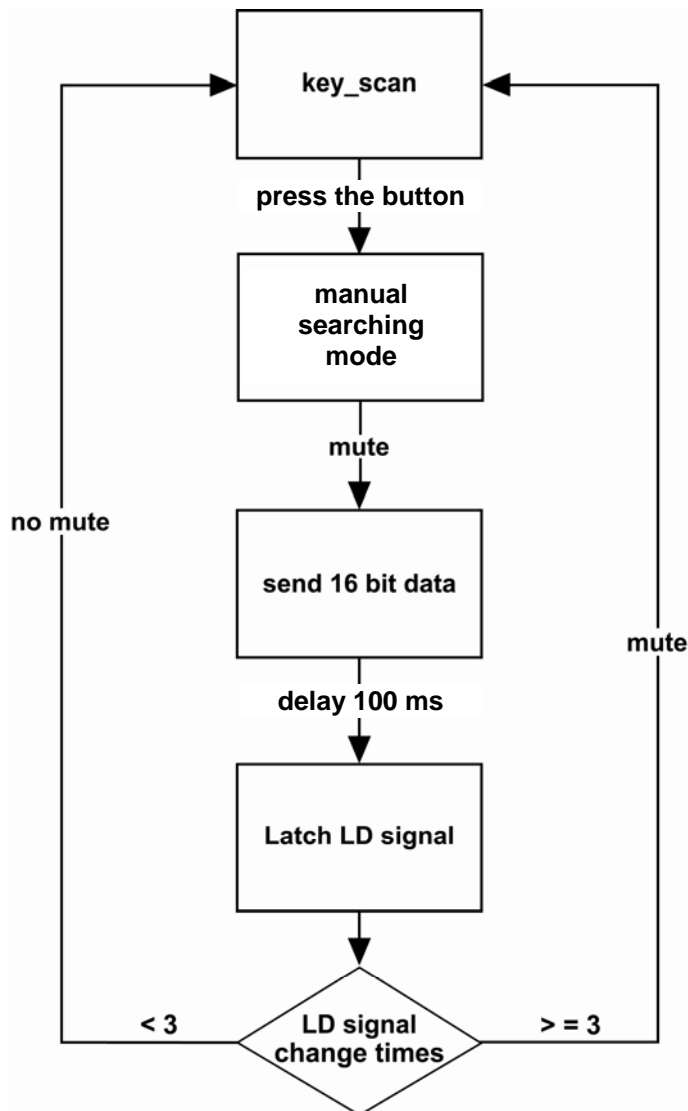
III. Using LD signals to tell whether a radio station has been successfully locked down:

1. The automatic scanning mode:

(**1**). Before starting the automatic scanning mode for searching radio stations, please turn off the audio output first, and turn it on after a radio station has been locked down.

(**2**). The sampling of LD signal cannot begin until the ending of CE signal (falling edge) has occurred and a delay of 150ms has passed.

(**3**). The time it takes for sampling LD signal is configured at 100ms, within this period of time, it is necessary to execute the sampling of LD signal every 1ms on average **(Note 1)**. If there was a single occurrence of "Low" for the outcome of LD signal sampling, it means no station has been locked down yet; but if the outcome of LD signal sampling is always "Hi", it means a radio station has been locked down (Please refer to **FIG. 1**).

**t1**: delay time (150 ms).   **t2**: the time it takes for sampling LD signals (100 ms).
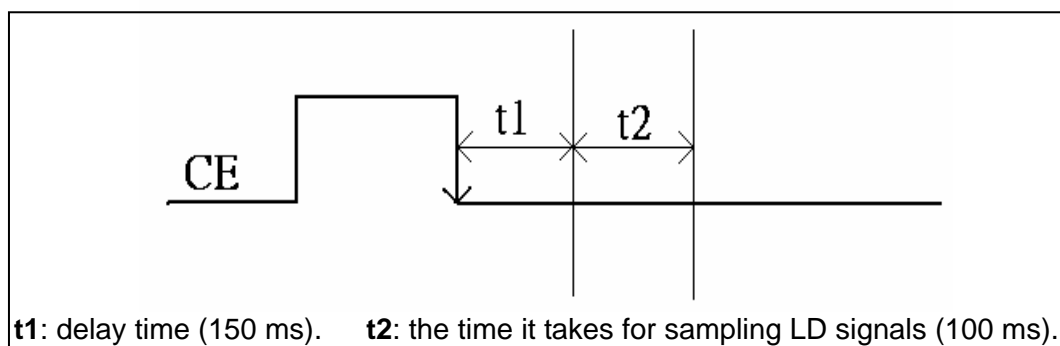
(FIG. 1)

Note 1:

The limit of 1ms is not fixed and can be adjusted by the customers on their own. But it should be noted that if the sampling time of 100ms is extended excessively, incidence of locking down the wrong radio stations could occur.

2. The manual searching mode:

(**1**). The sampling of LD signal cannot begin until the ending of CE signal (falling edge) has occurred and a delay of 100ms has passed.

(**2**). The time it takes for sampling LD signal is configured at 500ms, within this period of time, it is necessary to execute the sampling of LD signal every 1ms on average **(Note 2)**. When sampling, it is necessary to determine the number of times the LD signal has changed from 1 → 0 or 0 → 1; if the number of such changes is more than 3 times, please turn off the audio output.

(**3**). If the status of LD signal sampling has remained at "Low" in 500ms of sampling time (as in (2) described above), turn off the audio output (please refer to **FIG. 2**).

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t1: delay time (100 ms).   **t2**: the time it takes for sampling LD signals (500 ms).
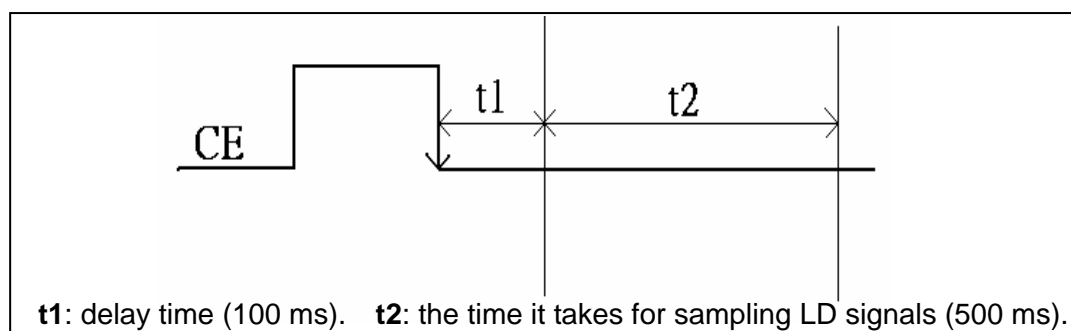
(FIG. 2)

Note 2:

The limit of 1ms is not fixed and can be adjusted by the customers on their own. But it should be noted that if the sampling time of 500ms is extended excessively, it becomes more difficult to solve the problem of noises (ie. radio cackle).

IV. Lowering the power consumption of MCU when shutting down the power of TR1001:

1. There are 5 signals that connect MCU to TR1001, they are CD, CK, DA, LD, and mute.

2. After switching off the power of TR1001, the status of the 5 signals between MCU and TR1001 can be set at "Low"; this can reduce unnecessary power consumption on the MCU I/O pins.