MART1600:

TEST MODULE TO RECORD AND PLAYBACK AUDIO MESSAGES USING ISD1600B IC SERIES

Rev. 2

1. CONSTRUCTION OF THE MODULE

MART1600 is a module designed to record and playback single audio signal (single message) using ISD1600B series integrated circuits of the American firm ***Winbond Electronics Corporation America (WECA)***. Made in non-volatile Multilevel Storage Technology (MLS), the ISD1600B circuits feature high quality audio recording, simplicity of operation and long-term retention of recording after switching off power (100 years). Control occurs through parallel pushbutton interface. It enables simple realization of the following functions without the need for additional control circuits:

- **level-triggered recording of audio message,**
- **edge-triggered playback of message,**
- **level-triggered playback of message,**
- **audio playback speed change,**
- **signalling of device state.**

Current state of the device (operation in progress) is indicated by a LED. After completion of each operation, ISD1600B ICs automatically enter into standby (power-down) mode, drawing current <1 µA.

Fig. 1 shows the circuit diagram of MART1600 module and Fig. 2 its PCB component layout. The following external components are required for proper operation of the module:

- stabilized power supply unit of voltage range +2.4 ... +5.5 V, connected to socket P1,
- 1W/8Ω speaker connected to terminal strip P3 or 0.5W/16Ω speaker connected to terminal strip P2.

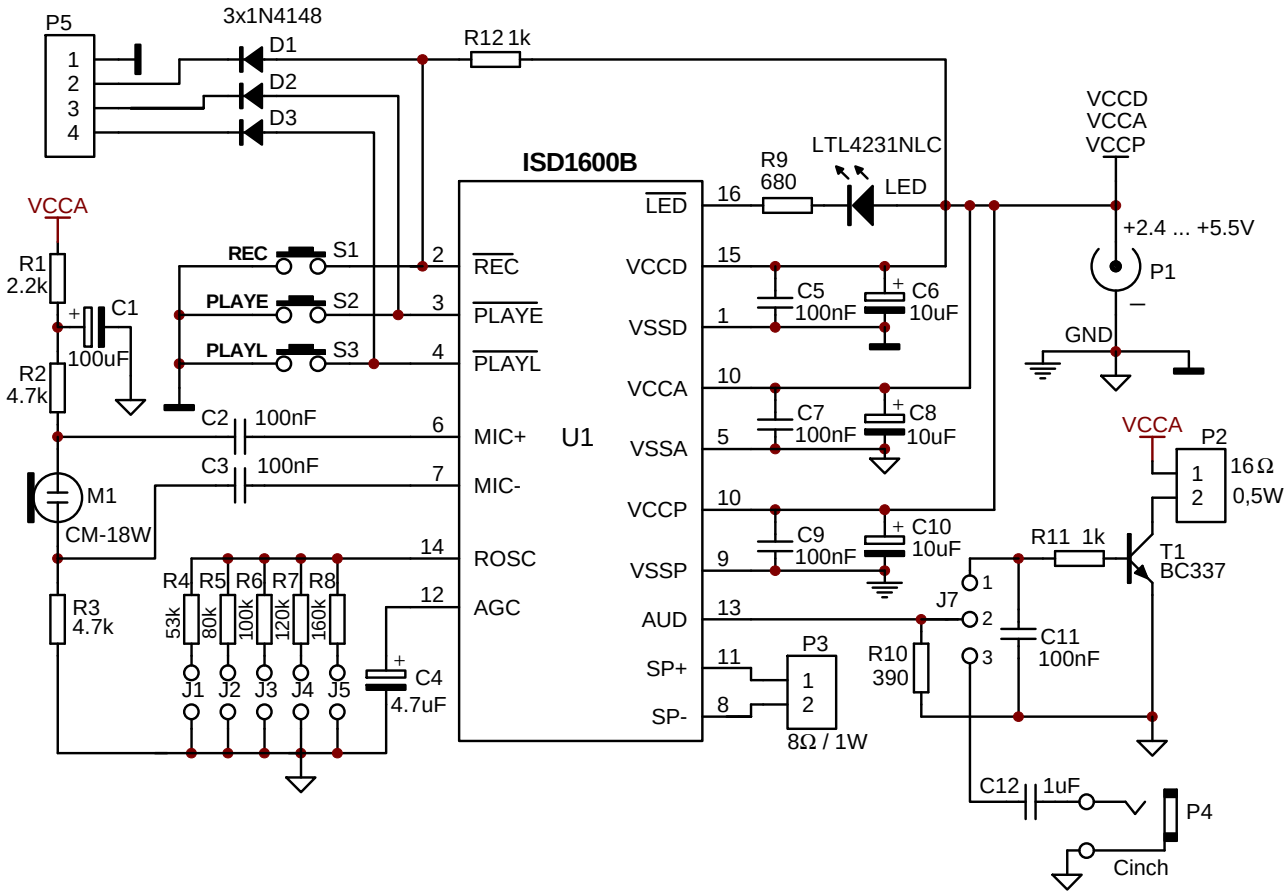

Fig.1. MART1600 circuit diagram.

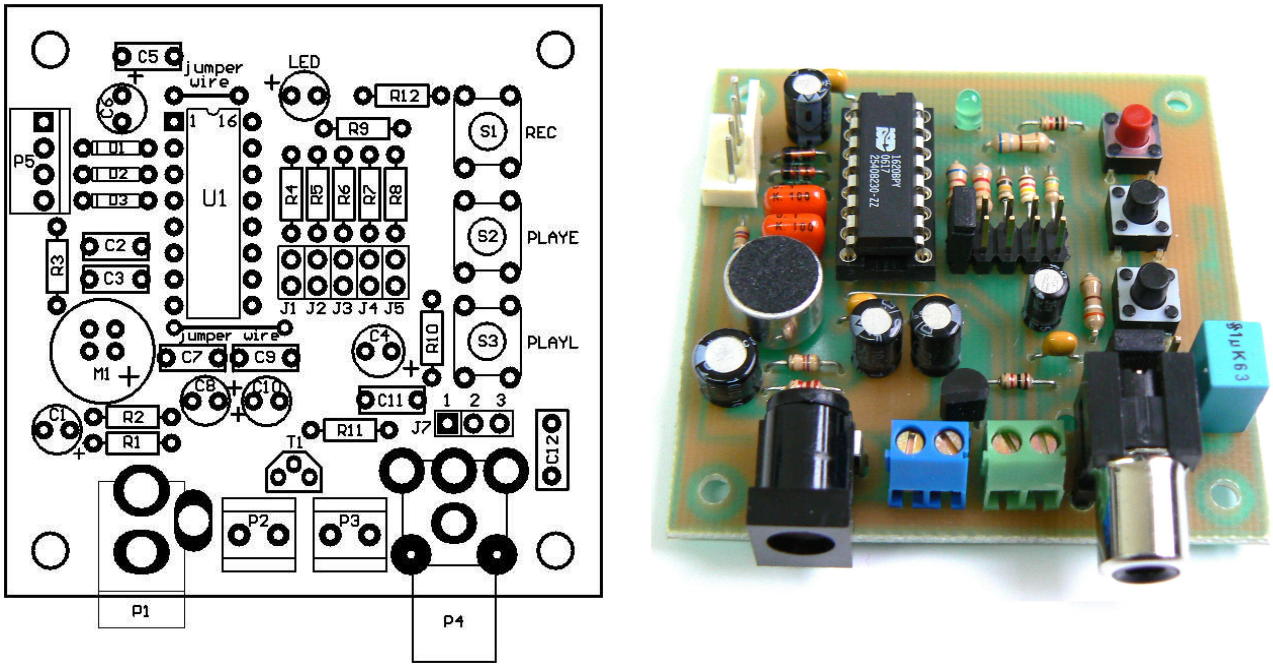

Fig.2. MART1600 PCB component layout (scale 1.4 : 1).

2. MODULE PORTS

The module contains mechanical components (switches S1...S3, jumpers J1...J5 and J7, output audio socket P4, speaker sockets P2 and P3) essential for realization of all the device functions. Moreover, input pins of control signals for actuating individual functions are additionally connected to plug P5, parallel to corresponding switches S1...S3. In this way, it is possible to actuate individual functions both by means of switches as well as external signals of appropriate logical levels.

Message is recorded into the system through microphone M1 provided in the module. Message playback is led to PWM type speaker outputs to which a speaker can be directly connected through socket P3. Simultaneously, the message is output either as an unamplified analog audio signal to socket P4 or after amplification to the speaker connected to socket P2 (depending on jumper J7).

The module is designed for supply with stabilized voltage in the range V_{CC} = 2.4 ... 5.5 V led to socket P1.

All control signals $\overline{\text{REC}}$, $\overline{\text{PLAYE}}$ and $\overline{\text{PLAYL}}$ of ISD1600B are digital signals accepting one of two possible voltages: low (logical L level) or high (logical H level), dependent on the power supply voltage Vcc. In case of ISD1600B series circuits, these voltages have following values with respect to ground:

- input low voltage: -0.3 V ... 0.3xVcc,
- input high voltage: 0.7xVcc ... Vcc,
- output low voltage: -0.3 V ... 0.3xVcc, max. 4 mA,
- output high voltage: 0.7xVcc ... Vcc, max. 1.6 mA.

Hereinafter, an alternative notation will be used for the state of a specific control signal (input/output):
signal name = L, H, LH, HL, where: LH – rising edge and HL – falling edge, of the signal.

All control inputs $\overline{\text{REC}}$, $\overline{\text{PLAYE}}$ and $\overline{\text{PLAYL}}$ of ISD1600B have internal pull-up resistors, forced H level on these pins and additionally have debounce circuits. Active state of these signals is L level.

S1 - the pushbutton for triggering REC function (input of $\overline{\text{REC}}$ signal) - level-activated recording of message.

S2 - the pushbutton for triggering PLAYE function (input of $\overline{\text{PLAYE}}$ signal) - edge-activated playback of message.

S3 - the pushbutton for triggering PLAYL function (input of $\overline{\text{PLAYL}}$ signal) - level-activated playback of message.

Pressing any pushbutton S1…S3 forces logical L level on corresponding control pin of ISD1600B.

P1 - 2.1/5.5 standard DC power supply socket - stabilized supply voltage in the range of 2.4...5.5 V.
P2 - terminal strip for 16Ω / 0.5W speaker connection – analog audio signal power amplifier output.
P3 - terminal strip for 8Ω/1W speaker connection – direct PWM outputs provide differential complementary speaker signals SP+ and SP- .
P4 - cinch socket for the analog audio output signal AUD.

P5 - control connector whose individual pins are connected in parallel with corresponding function switches S1...S3.

P5/1 - digital ground, (-) supply.
P5/2 - input of $\overline{\text{REC}}$ signal (connected with S1).
P5/3 - input of $\overline{\text{PLAYE}}$ signal (connected with S2).
P5/4 - input of $\overline{\text{PLAYL}}$ signal (connected with S3).

J1...J5 - jumpers for programming the sampling frequency (and hence the upper cut-off frequency) of recorded signal and its playback speed change. Specific sampling frequency is obtained by shorting relevant jumper with other jumpers open. Depending on selected sampling frequency, corresponding record duration is obtained as available in given version of ISD1600B. Approximate values of such durations are presented in Table 1 below.

Table 1

Jumper	Sampling frequency [kHz]	Upper cut-off frequency [kHz]	Max. record duration [s]			
			ISD1610B	ISD1612B	ISD1616B	ISD1620B
J1	12	5.1	6.6	8	10.6	13.3
J2	8	3.4	10	12	16	20
J3	6.4	2.7	12.5	15	20	25
J4	5.3	2.2	15	18	24	30
J5	4	1.7	20	24	32	40

J7 - the jumper for switching the kind of analog audio signal output:
- 1-2 closed - amplified analog audio signal is fed to the speaker connected to terminal strip P2,
- 2-3 closed - analog audio signal is fed to socket P4.

LED - the LED for indicating the kind of the operation in progress:
- turned on – record operation,
- blinks – playback operation.

3. PRINCIPLE OF OPERATION

ISD1600B enables recording of single audio message into internal non-volatile memory. Individual circuits have different memory sizes and hence different recording durations at specific sampling frequency - Table 1.

The module is provided with pushbuttons S1…S3 to force logical L state on individual control pins and to simultaneously actuate the corresponding system function. Instead of these pushbuttons, external control signals of appropriate logical values L or H fed to socket P5 can also be used for control.

For simplification, in further description of individual module functions, it is assumed that control is performed by means of the pushbuttons.

3.1. Programming the sampling frequency.

Before switching on the module, recording quality should be set to requirements, depending on sampling frequency of audio signal (in steps, 5 values from range 4…12 kHz). For this purpose, short the corresponding jumper J1…J5 according to Table 1. Depending on selected sampling frequency, appropriate message recording duration and recorded audio band is obtained. The best recording quality (upper cut-off limit 5.1 kHz) is obtained at sampling frequency 12 kHz. To obtain natural playback sound, the sampling frequency during recording and playback of the message must be the same. If message playback is at sampling frequency higher than while recording, the playback sound will be faster than recorded and will have higher pitch. Conversely, if message playback is at sampling frequency

lower than while recording, the playback sound will be slower than recorded and will have lower pitch. In this way, interesting sound effects can be achieved.

3.2. Recording a message (REC)

This function, triggered by the REC button or by L-level signal on P5/2 pin, enables recording a single message into the non-volatile memory. Maximum recording duration is determined by the type of ISD1600B used. Source of the recorded voice signal is microphone M1 built into the module. Recording starts from the beginning of the memory and is controlled by the level of $\overline{\text{REC}}$ signal, starting when the signal transits from H to L (HL edge) and stays on at L. Recording stops on LH edge of this signal.

- Press and hold the REC button ($\overline{\text{REC}}$=L). The device starts recording which continues until this button is released ($\overline{\text{REC}}$=H) or until end of memory. During recording the LED is turned on.

  When a record cycle is completed an End-of-Message (EOM) marker is automatically written at the end of message, which is used during playback. After recording the device automatically enters into standby mode. Recording takes precedence over playback operation, therefore if record operation is initialized during a playback, the playback will stop immediately and recording will start.

3.3. Edge-triggered playback of message (PLAYE)

This function, triggered by the PLAYE button or by L-level signal on pin P5/3, enables playback of recorded message entirely.

- Short pressing of the PLAYE button (short L-level pulse on $\overline{\text{PLAYE}}$) starts playback from the beginning of memory. This operation continues until end of the message (an EOM marker is encountered) or until end of memory.
- During playback the LED blinks a few times per second.
- Next short pressing of the PLAYE button after end of playback starts new playback from the beginning of memory.
- A subsequent short pressing of the PLAYE button during playback will terminate the current playback.

  After completing a playback operation the device automatically enters into standby mode.

3.4. Level-triggered playback of message (PLAYL)

This function, triggered by the PLAYL button or by L-level signal on pin P5/4, enables playback of recorded message from the beginning of memory, as long as $\overline{\text{PLAYL}}$ signal is active.

- Press and hold the PLAYL button ($\overline{\text{PLAYL}}$=L). The device starts playback which continues as long as $\overline{\text{PLAYL}}$ signal is held Low.
- During playback the LED blinks a few times per second.
- Playback is terminated in the following cases: when the PLAYL button is released ($\overline{\text{PLAYL}}$=H) or end of message or end of memory is reached.

  After completing a playback operation the device automatically enters into standby mode.

3.5. Voice alert function (vAlert)

This optional signalling function causes the LED to blink slowly (a few times per second) after completion of record operation to indicate that a new message exists. After playback is completed, the LED stops blinking and returns to the normal signalling mode.

ISD devices which have this function are marked as ISD1600B...**01**.

4. BASIC TECHNICAL DATA OF MART1600 MODULE

- Supply voltage: +2.4 ... +5.5V, stabilized.
- Record duration depending on type of ISD1600B: 10...20 s at 8 kHz sampling frequency.
- Non-volatile storage in ISD1600B, 100-year message retention without supply.
- 100 000 record cycles.
- Control modes: by means of buttons or external signals.
- Speaker output power (PWM type SP+ and SP- signals on terminal strip P3): 670 mW at 5.5 V supply voltage and 8 Ω speaker resistance.
- AUD analog signal voltage on output socket P4: max. 1.5 Vpp.

5. BIIL OF MATERIAL OF THE MODULE

Symbol	Type	Comments
Resistors (0.125 W):		
R1	2.2 kΩ	
R2, R3	4.7 kΩ	
R4	53 kΩ	
R5	80 kΩ	
R6	100 kΩ	
R7	120 kΩ	
R8	160 kΩ	
R9	680 Ω	
R10	390 Ω	
R11, R12	1 kΩ	
Capacitors:		
C1	100 µF/16V	electrolytic
C2, C3	100 nF	MKT type film capacitor
C4	4.7 µF/35V	electrolytic
C6, C8, C10	10 µF/35V	electrolytic
C5, C7, C9, C11	100 nF	ceramic
C12	1 uF	MKT type film capacitor
ICs:		
U1	ISD1600B	any IC from this series
Transistors:		
T1	BC337	h_{fe} classification: 25
Diodes:		
D1, D2, D3	1N4148	switching diode
LED	LTL4231NLC	green, low-current, 3 mm
Other components:		
M1	CM-18W	electret microphone
S1	DTS-63R	tact switch 6x6 mm, NO, dist. TME (www.tme.pl/index.phtml?lang=en)
S2, S3	DTS-63K	tact switch 6x6 mm, NO, dist. TME
P1	PC-GK2.1	DC power socket for PCB, 2.1/5.5 type, dist. TME
P2, P3	TB-3.8-P-2P-BL or TB-3.8-P-2P-GY	terminal strip 3.81 mm, 2-pin, dist. TME
P4	PHS-2B	chinch socket for PCB, dist. ELFA (www.elfa.se)
P5	22-27-2041	plug for PCB, straight, pitch 2.54 mm, 4-pin, dist. ELFA
J1, J2, J3, J4, J5	MX-90120-0122	pin header for PCB, male vertical, pitch 2.54 mm, 2-pin, dist. TME
J7	MX-90120-0123	pin header for PCB, male vertical, pitch 2.54 mm, 3-pin, dist. TME

Some of these components, mainly mechanical components (switches, sockets, headers), can be replaced with their equivalents of other firms.