

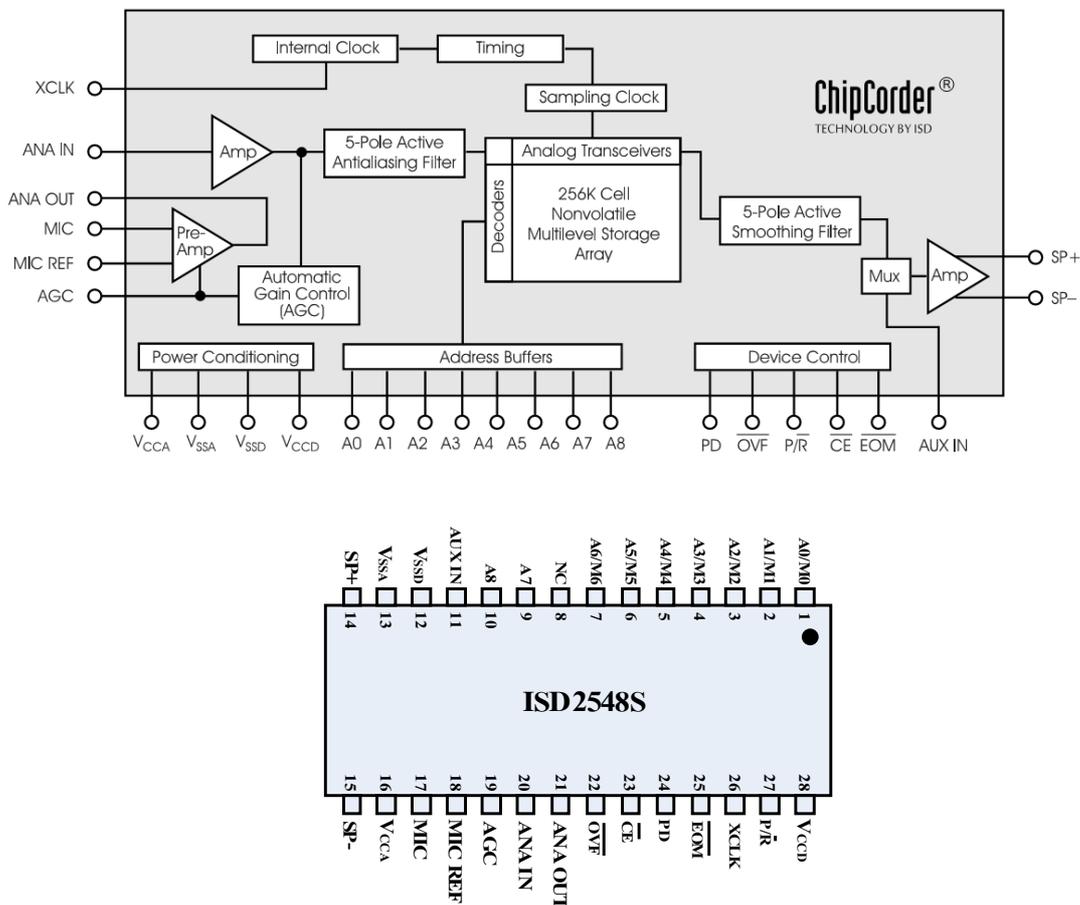
ET-MINI ISD2548

Board ET-MINI ISD2548 is used to record sound and playback the recording; it is suitable to record any sound/message that is not longer than 48 seconds/a board. It uses MCU Serial Data Interface (SPI) through IC#74HC595 to control recording and playing back; it reduces amount of Pin I/O of MCU that controls the operation of ISD2548 (normally, ISD2548 uses the Parallel Interface to control the operation that wastes much Pin I/O).

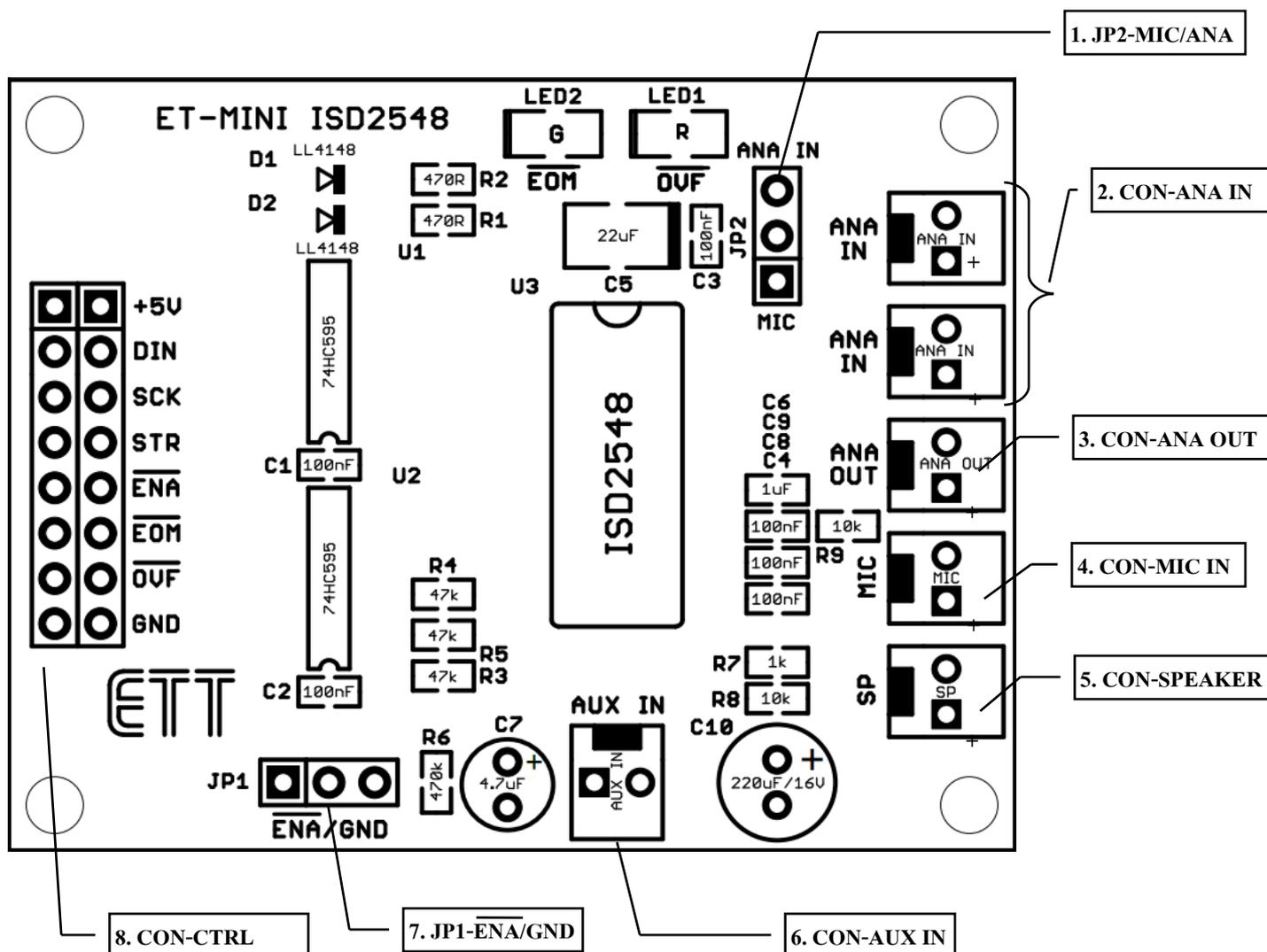
1. Specifications of Board ET-MINI ISD2548

- Be more convenient to record and playback the recording
- Use Microcontroller to control operation
- Address Mode: It can set the initial position to recode or playback sound from Pin Address of Chip (A0-A8)
- The maximum length to record sound is 48 seconds per a Chip
- Has 320 Message Addresses: 1 Address can record sound for 150 msec or 0.15 second
- Input Sample Rate 5.3 KHz, Filter Pass Band 2.3 KHz (On-Chip Clock Source)
- Can interface with headphone or be interfaced though amplifier for Signal Output
- The recording sound is not erased although it is Power Off, it is unnecessary to use any battery for Backup.
- 100,000 times to record and it can maintain the recording up to 100 years
- Provide +5VDC Power Supply for Board ET-MINI ISD2548
- Temperature range: -40 to +85°C

2. Structure and Block Diagram of Chip ISD2548



3. Structure of Board ET-MINI ISD2548



- 1. JP2-MIC/ANA:** It is Jumper to choose the preferable INPUT Channel to record sound. If it sets this Jumper to the side of ANA-IN, it records external Line Out that is interfaced through Connector ANA In (No.2); in this case, it is independent to choose any channel to interface with because it is parallel interface. Or, if it sets this Jumper to the side of MIC, it records sound from microphone that is interfaced through Connector MIC (No.4).
- 2. CON-ANA IN:** This Connector Input receives Signal Analog Sound from external sound generator and it records that sound in ISD2548. In this case, user can choose any connector to interface with because both connectors are parallel interface.
- 3. CON-ANA OUT:** This is Connector Output of Pre-Amp that receives Signal Input from Channel MIC. This Signal Output can be interfaced with Amplifier to expand the signal stronger.
- 4. CON-MIC IN:** This is Connector Microphone to record sound from user and store it in ISD2548.
- 5. CON-SPEAKER:** This Connector Output Amplifier is used to interface with headphone or external amplifier. This Signal Output occurs because

of playing back sound that has been recorded by user, or sound that is sent from Connector AUX IN.

6. **CON-AUX IN:** This Connector is used to receive external sound to expand and then send to Output Amplifier. In this case, it sends to Connector CON-SPEAKER, it does not record any sound into ISD2548.
7. **JP1- \overline{ENA} /GND:** This Jumper is used to choose the way to control Pin \overline{ENA} of both Shift Registers 74HC595 on board. If it sets this Jumper to the side of GND, both of Shift Register is enabled or it is ready to run all the time. Or, if it sets this Jumper to the side of \overline{ENA} , user can control Enable of both Shift Registers by self through Connector CON-CTRL at Pin \overline{ENA} .
8. **CON-CTRL:** This Connector is used to interface signal from MCU to control operation of ISD2548; moreover, it reads the operating status of ISD2548. Details of each pin are described as follows;
 - **+5V and GND:** It interfaces with +5VDC Power Supply for board.
 - **DIN:** This Pin receives 8BIT Serial Data (SPI) from MCU.
 - **SCK:** This Pin receives Signal Clock (SPI) from MCU to shift data in Shift Register. It runs at the Rising Edge Pin.
 - **STR:** This Pin receives Signal Strobe from MCU and it runs at Logic '1'. It is used to serially release the received data from both Shift Registers; it sends out through Output in the format of parallel to Pins of ISD2548.
 - **ENA:** This Pin receives Signal \overline{ENA} from MCU to enable the operation of both Shift Registers by Active '0'.
 - **EOM:** This Pin Output expresses the status of ending; ISD2548 sends Signal \overline{EOM} to this Pin and MCU reads this data. When it is in the normal status, it is Logic '1'; or, if it finishes playing any message, it sends Logic '0' for 18.75 ms and then it becomes Logic '1' automatically (when using, it has to interface R-Pull Up 10K with this Pin).
 - **OVF:** This Pin Output expresses the status of memory of ISD2548 when it is full; ISD2548 sends Signal \overline{OVF} to this Pin and MCU reads this data. When it is in the normal status, it is Logic '1'. Or, when the memory is full, this Pin is Logic '0' and it holds this status for a while; When ISD2548 is reset, this 0 becomes Logic '1' as normal (when using, it has to interface R-Pull Up 10K with this Pin).

4. Initial Operation of ISD2548

This ISD2548 can record sound for 48 seconds and there are 320 Message Addresses; so, 1 Message Address can record for $48/320 = 0.15$ second. The value above is important when using MCU to control playback and record.

There are 2 main operation modes that user can choose for this ISD2548; **Address Mode** and **M-Mode**. In case of **M-Mode**, there is a sub-mode that is Push-Button Mode that is used to control format of playing sound with M-Mode. However, this document only describes how to use ISD2548 in Address Mode and Push-Button Mode, according to examples in CD-ROM; moreover, it only mentions how to use MCU to be controller device for playing back and recording sound. For other information, user can read from Data Sheet of ISD2548.

4.1) Address Mode

This operation mode uses Pin A0-A8 to setup the preferable Address to playback and record sound. Pin A7 and A8 are used to choose operation mode; in this case, it has to set it to be '00' or '01' or '10', and ISD2548 can run in this operation mode. There are 320 Message Addresses of ISD2548; so, it can refer to Address position in the range of 0-319 or 000000000b - 100111111b (0x000-0x13F). In this case, the highest Address position still sets Bit A7 and A8 to be in the range of 3 statuses; 00, 01, 10 as mentioned above. Remember, if user requires using this operation mode, the Address position that is referred to record and playback sound is not exceeded 0x31F only; and it always runs in this operation mode. There are 3 Pins that are used to control recording and playing back as follows;

- 1) **CE**: This Pin receives Signal Pulse Active Low (normally, it should be High); it controls Start Playback or Start Record.
- 2) **PD**: This Pin receives Signal Pulse Active High (normally, it should be Low); it resets ISD2548. If it is playing back or recording, it stops immediately; moreover, the position of Message Address is pointed to the current position that user has set at Pin A0-A8.
- 3) **P/R**: This Pin is used to record or playback. If it is High, it playbacks; or, if it is Low, it records.

There are 2 Pins that are used to express the operating status of ISD2548 as follows;

- 1) **EOM**: Every time after it finishes playing message, ISD2548 sends Signal Pulse Low with 18.75ms Width to this Pin to notify user to know that it finishes playing the message and the Signal Pulse **E $\overline{O}F$** becomes High automatically.
- 2) **O $\overline{V}F$** : This Signal is Pulse Low when the memory space of ISD2548 is full, or it records sound until the memory of ISD2548 is full as well. This Signal is Low until it resets ISD2548 at Pin PD, and then this Signal becomes High.

4.1.1) How to Record in Address Mode

- 1) Set initial Address that user prefers to record sound at Pin A0-A8; in this case, it can set Address in the range of 0x000-0x13F. For example, if user records sound at Address 0x005, it has to set Pin A0,A2 = '1', and it sets the rest of Pin Address to be '0'.
- 2) Set Pin PD to be Low; it exits from status of Reset and ISD2548 is ready to run.
- 3) Set Pin **P/R** to be Low; it chooses record mode.
- 4) Set Pin **C \overline{E}** to be Low and hold it for a while; next, user can input the preferable message to recode and it starts recording the message into the specific Message Address in step No.1. When the Message Address records the message until it is full, it automatically increases the new Address if it still records (**C \overline{E}** is still LOW). As mentioned above, 1 Address can record for 0.15 second at the maximum. If it records message until the memory space of ISD2548 is full, it sends Signal Overflow as Pulse Low through Pin OVF to notify user to know that the memory is full; so, any new incoming sound is ineffective.
- 5) When it stops recording, user has to set Pin **C \overline{E}** to be High and Signal **E $\overline{O}M$** is recorded into the address memory next to the message that has been recorded previously. When user requires recording other messages into the next address, it should return to step no.2 and repeats processes. Moreover, user should consider that any Address that is used to record new message must not overlap the Address of previous message; otherwise it makes some previous message lost.

If user records several short messages into the same ISD2548, user can set the initial Address position to record, but user does not know where the exact Address position of the recorded message ends; so, it is difficult to set Address for the next message. In this case, we would like to suggest user to record each message by setting equal period and then measure time taken. When it records message until it reaches the specific time, it stops automatically and user can set the initial Address position for the next message, without any overlap (please read more examples in CD-ROM from examples "Ex1_Play_Record"). This is an example when user requires recording short message that is not longer than 2 seconds; because 1 Address can record message for 0.15 second as mentioned in the specification of ISD2548 above, so it needs to use Address that equals $2/0.15 \sim 14$ Address for 1 message. If it starts recording the first message at Address 0; the second message has to record at Address 15; the third message has to record at Address 30, and so on. When it starts recording message at Address 0 and user adds more 14 Addresses, the message must end at the position that is not greater than Address 13. Next, user has to add 1 more Address for Signal $\overline{\text{EOM}}$; so, the first message must be ended at Address 14 and the second message must be started at Address 15. In this case, don't forget to add 1 more Address in each message to record Signal $\overline{\text{EOM}}$, otherwise Signal $\overline{\text{EOM}}$ will be recorded and overlapped the Address position that has been recorded previously and it cannot separate the end of each message while playing back. In summary, this is the method to calculate amount of the used Address, according with the preferable length for each message;

Amount of the used Address = [length of message(second)/0.15(second)]+1 (EOM Address)

When user keeps writing program until it reaches the step No.4 that is $\overline{\text{CE}}=\text{Low}$, it starts recording message. In this case, it should set Time Delay for 2 seconds, according to the length of message. When Time Delay 2 second is completed, user can go to step No.6 to stop recording the message ($\overline{\text{CE}}=\text{High}$).

4.1.2) How to Playback in Address Mode

- 1) Set initial Address that user requires playing back at Pin A0-A8; in this case, it can set Address in the range of 0x000-0x13F. For example, if it starts playing back at Address 0x005, it has to set Pin A0,A2='1', and it sets the rest of Pin Address to be '0'.
- 2) Set Pin PD to be Low; it exits from status of Reset and ISD2548 is ready to run.
- 3) Set Pin $\overline{\text{P7R}}$ to be High; it chooses Playback mode.
- 4) Set Pin $\overline{\text{CE}}$. When setting this Pin $\overline{\text{CE}}$, it has 2 effects on the Playback mode as follows;
 - Set and hold Pin $\overline{\text{CE}}$ to be Low (it normally is High); the message position that is pointed by the specified Pin Address in the step No.2 will start playing instantly. While playing back, Pin $\overline{\text{EOM}}$ is High. When it finishes playing message, ISD2548 sends Signal Low to Pin $\overline{\text{EOM}}$ for 18.75ms and then it becomes High again; user can use this pin to check the end of playing message. When the first message ends, it starts playing the second and third message continuously and it always sends out Signal $\overline{\text{EOM}}$ Logic Low when it ends of playing each message. It continues playing messages until Pin $\overline{\text{CE}}$ is set to be High, or it plays until it reaches the end of Address of Memory ISD2548, it stops. If Pin $\overline{\text{CE}}$ is set to be High while playing message, the message that is playing continues playing until it ends, and it stops. When it stops playing, it sets Pin $\overline{\text{CE}}$ to be Low again; in this case, the first message that is pointed by Pin Address in step No.1 re-starts playing instantly.
 - Set Pin $\overline{\text{CE}}$ in the format of Push, it means that it sets Pin $\overline{\text{CE}}$ from High to Low and then set it to be High instantly, the message that is pointed

by the specified Pin Address in step No.1 starts playing instantly. While playing message, Pin $\overline{\text{EOM}}$ is High; when it finishes, ISD2548 sends Signal Logic Low to Pin $\overline{\text{EOM}}$ for 18.75ms and it becomes High again and it finishes playing the message. If user requires playing the next message, it has to check if the Signal $\overline{\text{EOM}}$ becomes High, and then user can return and repeat steps from No.1 to play the next message.

- 5) If user stops while playing message; it sets Pin PD to be high and it makes ISD2548 is in status of Reset.

4.2) Operation in Push-Button Mode (sub-mode of M-Mode)

When using this operation mode, it has to set Pin A6,A7,A8 to be High; function of Pin A0-A5 is changed to Pin M0-M5 and each pin has different function. Normally, when it is interfaced with Pin M0-M5, it should set Full Down; if user requires running any pin according to its function, it only sets that pin to be High. As mentioned above, user can set the preferable pin by Active to High; moreover, user has to set other Pin Controls together, it depends on the operating format of each pin. We do not describe in this section, please read more information from Data Sheet.

The operation of this Push-Button Mode is to record and playback by using Pin Control $\overline{\text{CE}}$, D, $\text{P}/\overline{\text{R}}$ and $\overline{\text{EOM}}$; its function is similar to Address Mode. Function of each pin is described below;

- 1) **Pin $\overline{\text{CE}}$:** This Pin receives Signal Pulse Active Low (High \rightarrow Low); it is used to control START or PAUSE for playback and record. It starts playing back or recording message when this Pin receives the Signal Pulse Low; while playing back if it sends the Signal Pulse Low to this pin before Signal $\overline{\text{EOM}}$ or $\overline{\text{OVF}}$ happens, it temporarily stops (PAUSE) instantly. However, if it sends this Signal Pulse Low to this pin again, it returns to playback message and it starts at the paused position.
- 2) **Pin PD:** This Pin receives Signal Pulse Active High (Low \rightarrow High); it is used to control STOP or RESET for playback and record. When the status of STOP/RESET happens, it stops playing or recording message instantly, and Address Pointer of Message is reset to be 0x000 again. If user commands to play or record new message, it always starts playing or recording at Address 0x000 again. Every time this Pin is Active, the status of STOP/RESET always happens and Pointer Address always points to the initial Address of 0x000 as well.
- 3) **Pin $\text{P}/\overline{\text{R}}$:** This Pin is used to choose operation modes between Record and Playback. If this Pin is set to be High, it chooses 'Playback' Mode; or, if this Pin is set to be Low, it chooses 'Record' Mode.
- 4) **Pin $\overline{\text{EOM}}$:** This Pin is Output that shows operating status of playback and record; in this case, it can interface with LED to shows the operating status. It shows the status of High when it is playback or record; or, it shows the status of Low when it is not playback or record. When managing message in this Mode, user cannot refer to any Address directly unlike Address Mode; in this case, it uses the way to control function of Pin M0-M5 to manage message instead. When it starts running, or it resets, or it changes function from Record to Playback or from Playback to Record, the initial Address that is referred internal ISD2548 of this mode is always Address 0x000; it does not depend on Pin A0-A8. Next, we will mention the procedure for record and playback in this mode.

4.2.1) Procedures for Recode in Push-Button Mode

- 1) Set Pin A6-A8 to be High to choose Push-Button Mode; and it should set Full Down for Pin A0-A5 or set these pins to be Low.
- 2) Set Pin PD to be Low, it exits from the status of Reset and ISD2548 is ready to run.
- 3) Set Pin P/\bar{R} to be Low, it chooses Record mode.
- 4) Set Pin \bar{CE} in the format of Pulse Low; it means that it sets Pin \bar{CE} from High to Low and then set it to High again, it starts recording. The status of Pin \bar{EOM} that normally is Low changes to High, it shows status of record and it starts recoding at Address $0x000$.
- 5) When Pin \bar{CE} receives Pulse Low again, it stops recording message instantly; the signal at Pin \bar{EOM} changes from High to Low to show that it stops recording. Address Pointer of the memory has not been cleared yet after the end of record. Every time EOM Marker will be stored in the Address memory after the currently recorded message; this EOM marker is an identifier for the end of each message. Meanwhile, if Pin P/\bar{R} is set to be High for Playback and \bar{CE} receives Signal Pulse Low, the Playback should be started at Address $0x000$. On the other hand, if Pin P/\bar{R} is set to be Low for Record again and Pin PD still is Low, it starts recording into the Address position after the recent Address position of Playback.

If it records message until the memory of ISD2548 is full, Signal at Pin \bar{EOM} changes from High to Low automatically; it notifies user to know that the record ends and the memory is full, without sending any Pulse Low to Pin \bar{CE} by oneself to stop recording as usual.

- 6) After it stops recording if user still provides Signal Pulse Low to Pin \bar{CE} , it starts recording again; it starts recording after the Address position that records \bar{EOM} Marker of the previously recorded message. Moreover, the status of Pin \bar{EOM} is changed from Low to High to show status of Record and the next message will be recorded in the continuous Address position respectively; in this case, it returns and repeats step No.5 and No.6, alternately.

To record each message, after user has done step from No.1 to No.4 completely, user has to do step No.5 and step No.6 alternately. Finally, messages will be recorded in the continuous Address positions and each message is separated by \bar{EOM} Marker to be the identifier of the end. While recording or after recording any message completely but ISD2548 is reset by any cause; for example, PD is set to be High and then become Low again. After Reset if user requires recording any message again, it always returns to the Address $0x000$ to record; it does not record any message after the Address position of the previously recorded message. It means that if ISD2548 is reset, Address Pointer of the memory is also reset. Moreover, if it records new message, it always overlaps the old message; or, if the new message is shorter than the old one, the old recorded message still remains.

4.1.2 Procedures for Playback in Push-Button Mode

- 1) Set Pin A6-A8 to be High to choose Push-Button Mode; other Pin A0-A5 should set Full Down or Low.
- 2) Set Pin PD to be Low; it exits from status of Reset and ISD2548 is ready to run.
- 3) Set Pin P/\bar{R} to be High; it chooses Playback mode.
- 4) Set Pin \bar{CE} in the format of Pulse Low; in this case, it sets Pin \bar{CE} from High Low and then set it to be High again, it starts playing back the message. Normally, the status of Pin \bar{EOM} is Low and it becomes High to show status of Playback. It starts playing back at Address $0x000$. When it ends of playing back any message, it stops automatically and status of Pin \bar{EOM} changes from High to Low.

- 5) If it sends more Pulse Low to Pin \overline{CE} while playing any message, it temporarily stops (PAUSE); Address Pointer is not reset and signal at Pin \overline{EOM} is changed from High to Low. While it is in the status of PAUSE if user sets Pin P/\overline{R} to be Low for Record and the status of Pin PD is still the same; it starts recording when user sends Signal Pulse Low to Pin \overline{CE} , and it stops when user sends Signal Pulse Low to Pin \overline{CE} again. The new message will be recorded after the Address Pointer of the recently recorded Message; it does not start at Address Pointer $0x000$.
- 6) Refer to the step No.4 above; after the end of playing any message, it stops automatically. If user requires playing the next message, it has to send Signal Pulse Low to Pin \overline{CE} again, the next message after the first message will be played instantly. In this case, every time user sends Signal Pulse Low to Pin \overline{CE} after the end of the previous message, the next message always played until it overflows or Pin PD is set to be High, and then Address Pointer is reset to be $0x000$. When user requires playing back, it has to return step No.1; starts playing message at the Address $0x000$ again.

User can set trick of playback in this Pulse-Button Mode such as Skip Message, Repeat the first message; in this case, it uses Pin M0-M5 to set tricks as example below;

- How to use Pin M3 to repeat message at Address Pointer $0x000$ (only repeat the first message)

If user to set Repeat message, it can set value while playing back any message or not playback; in this case, it has to set Pin PD to be Low and Pin P/\overline{R} must be still High. If user requires repeating the first message, it has to set Pin M3 that normally is Low to be High first and provides Signal Pulse Low to Pin \overline{CE} , the first message is playback. When it finishes playing the first message completely, it repeats the first message instantly.

If user requires exiting from repeat message, it has to set Pin M3 from High to Low and then provide Signal Pulse Low to Pin \overline{CE} ; it will exit from repeat message instantly.

To set repeat message or exit from repeat message, if user sends Signal Pulse Low to Pin \overline{CE} while is playing back, it temporarily stops playing back (PAUSE) as well; so, it has to send the second Signal Pulse Low to Pin \overline{CE} again or the second wave instead. In this case, it continues playing the current message until it finishes, and then it restarts playing back if set MP3 to repeat; or, it stops instantly is it sets MP3 to exit from repeat.

- How to use Pin M0 to skip unwanted message

To skip any message, it can set value while playing back or not playback any message; in this case, it has to set Pin PD to be Low and Pin P/\overline{R} is still to be High. When user requires skipping any unwanted message, it has to set Pin M0 that is normally Low to High, and then provides Signal Pulse Low to Pin \overline{CE} ; in this case, amount of unwanted message to skip and Signal Pulse Low that is sent to Pin \overline{CE} must be equal. Next, it has to set Pin M0 from High to Low, and provides Signal Pulse Low to Pin \overline{CE} again; the message after the skipped message will be played back instantly.

5. How to use Board ET-MINI ISD2548

As mentioned in section 4 above, all describe how to control the operation at Pin I/O of ISD2548 directly. In case of Board ET-MINI ISD 2548, there is Shift Register #74HC595 that is interfaced between ISD2548 to reduce amount of Pin I/O for controlling operation of ISD2548. This Shift Register is used to send/receive data in the format of Serial-In/Parallel-Out that uses SPI Interface; so, it has to use MCU to be intermediate between receiving and sending data to control the operation of ISD2548. In this case, Data that is sent out to control the operation must accord with the process of ISD2548 as mentioned in the section 4 above.

5.1) How to send data as SPI

First of all, user should understand the operation of sending/receiving data in the format of SPI first. This Shift Register number is 8-Bit or 1 Byte Shift Register and it uses 12Bit Data to control ISD2548; so, it has to totally send 12Bit Data in each time to control operation of ISD2548. It arranges Pin Control of ISD2548 according to the Bit Data that will be sent out as follows;

Bit-Data	Bit-11	Bit-10	Bit-9	Bit-8	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0
PIN-Control ISD2548	CE	PD	P/R	A8	A7	A6	A5	A4	A3	A2	A1	A0
Mark-Data	X	X	X	X	X	X	X	X	X	X	X	X

X = Mark data 0 or 1

Initially, user has to mark Data first to see what each bit is, please refer to the process in the section 4 above. When user has marked the Data completely, user will get the Data that will be sent out to control ISD2548. The first Bit that is sent out is Bit-11; in this case, MCU sends the first data bit to Pin-Din. Next, MCU sends the first Signal Clock at the Rising Edge Pin (Low to High) to Pin-SCK to shift the first data bit and stores in Register of 74HC595. Next, MCU sends the 10th Bit to Pin-Din and then follows by the second wave of Signal Clock; user has to do this process until all 12Bit Data is complete (until all 12 Clock waves are complete). The Data that is sent is arranged in both Shift Registers that are matching with Pin positions of ISD2548 as shown in the table above. Finally, MCU sends Signal Clock at Rising Edge Pin (Low to High) to Pin STR to release the data that is received and stored in Shift Register to the side of the Parallel Output. Data that is released is used to control Pin I/O of the interfaced ISD2548; the ISD2548 operates according to the timing of sending Data in each time; and it finished sending Data one time.

When user understands principles of sending 'SPI' Data serially well; next, it uses this format of sending data to control operation of ISD2548 according to the process as mentioned in the section 4 above.

5.2) How to use ET-MINI ISD2548 in Address Mode

5.2.1) Procedures for recording (RECORD): In this case, it starts recording at Address 0x000 through the Channel MIC.

- 1) Interface I/O (OUTPUT-PIN) of MCU with Pin \overline{DIN} , SCK, STR of Board ISD2548.
- 2) Interface I/O (INPUT-PIN) of MCU with Pin \overline{EOM} of Board ISD2548 (it is used for Playback Mode).
- 3) Interface Microphone with Connector MIC to record and then set JUMPER JP2 to the side of MIC. If user requires recording from Line Out of other sound generators it has to interface Signal Line-Out with any Connector ANA_IN of Board ISD2548 and then set Jumper JP2 to the side ANA_IN instead.
- 4) Set Jumper JP1 to the side of GND to Enable Shift Register 74HC595; or, if user would like to control Enable by MCU by oneself, it has to set Jumper JP1 to the side of \overline{ENA} and then it interfaces PIN \overline{ENA} to Pin Output of MCU to control the operation.
- 5) Provide 5V Power Supply for Board ET-MINI ISD2548.
- 6) MCU sends the first data set 0xE00 ($\overline{CE}, PD, P/\overline{R} = 1$ and set the initial Address A0-A8 =0) to Board ISD2548 for Initial ISD2548.
- 7) MCU sends the second data set 0x800 ($PD, P/\overline{R} = 0$), it makes the ISD2548 release from the status of Reset and it runs in Recode Mode. For other rest Bits, it still remains.
- 8) MCU send the third Data set 0x000 ($\overline{CE}, PD, P/\overline{R} = 0$), it sets Pin \overline{CE} to be Low. After sent this Data set completely, user can record any data by microphone instantly.
- 9) If it stops recording, MCU sends the forth Data set 0xE00 to set Pin $\overline{CE}, PD, P/\overline{R}$ to be '1', it sets ISD2548 to be in the initial status again.
- 10) If user requires recording new message into other Addresses, it should return step No.6 and repeat procedures. In the part of Bit-Data at the Address A0-A8, it has to replace by the preferable Address; it starts recording (0x000-13F) and Bit Position of $\overline{CE}, PD, P/\overline{R}$ still the same as mentioned above. For example, if user requires recording at Address 0x20; the first Data set that will be sent out is 0xE20; the second Data set should be 0x820; and the third Data set should be 0x020.

It is easier to record if using Push-Button Switch; it is interfaced with MCU and checks the status of pressing switch. If the switch is pressed, MCU sends out the Data in step No.6-8 and user can record any data while pressing SW. When the switch is released from pressing, MCU sends out the Data in step No.9 to stop recording.

5.2.2) Procedures for Playback: In this case, it starts Playback at Address 0x000.

- 1) Interface I/O (OUTPUT-PIN) of MCU with Pin \overline{DIN} , SCK, STR of Board ISD2548.
- 2) Interface I/O (INPUT-PIN) of MCU with Pin \overline{EOM} of Board ISD2548. This Bit \overline{EOM} is not interfaced through Shift Register, so it can use MCU to read values directly.
- 3) Interface headphone or amplifier at Connector SP.
- 4) Set Jumper JP1 to the side of GND to Enable Shift Register 74HC595; or, if user would like to control Enable by MCU by oneself, it has to set Jumper JP1 to the side of \overline{ENA} and then interface Pin \overline{ENA} to Pin Output of MCU to control operation by oneself.
- 5) Provide +5V Power Supply for Board ET-MINI ISD2548.
- 6) MCU sends the first Data set 0xE00 ($\overline{CE}, P/\overline{R}, PD = 1$ and Set Initial Address A0-A8 = 0) for Initial Address to run in Play Mode. If the Initial Address of play is not 0x000, it should be replaced by the Address in the new Bit position A0-A8 instead.

- 7) MCU sends the second Data set $0x200$ (\overline{CE} , PD = 0); it sends Clock Pulse Low to Pin \overline{CE} of ISD2548 and it releases from the status of Reset. Other rest Bits, it is still the same.
- 8) MCU sends the third Data set $0xA00$ (\overline{CE} =1); it sends Clock Pulse High to Pin \overline{CE} of ISD2548. Other rest Bits, it is still the same. After sent this data set, it starts playing back at the Address that is set in Bit A0-A8.
- 9) MCU read Bit \overline{EOM} from ISD2548 repetitively (loop). If the value that is read is '1', it means that it is still playing message; or, if the value that is read is '0', it means that it finishes playing the message. When \overline{EOM} is '0' completely, it should check and set the status of Signal \overline{EOM} to be '1' before playing the next message because it sets ISD2548 to be ready to run first. If user requires playing any message in other Address positions, it should return and repeat the step No.7.
- 10) If it stops playing back message before sending Signal \overline{EOM} , MCU has to send Data $0xE00$ to stop playback instantly; in this case, it looks like Initial ISD548.

5.3 How to use ET-MINI ISD2548 in Push-Button Mode

5.3.1) Procedures of recording (RECORD)

- 1) Interface I/O (OUTPUT-PIN) of MCU with Pin \overline{DIN} , SCK, STR of Board ISD2548.
- 2) Interface I/O (INPUT-PIN) of MCU with Pin \overline{EOM} of Board IS2548 (This Mode uses \overline{EOM} to notify the operating status).
- 3) Interface microphone with Connector MIC to record and it has to set Jumper JP2 to the side of MIC. If user requires recording from Line Out of other sound generators, it has to interface Signal Line-Out with any Connector ANA-IN of Board ISD2548 and then set Jumper JP2 to the side of ANA_IN instead.
- 4) Set Jumper JP1 to the side of GND to Enable Shift Register 74HC595; or, if user would like to control Enable by MCU by oneself, it has to set Jumper JP1 to the side of ENA and then interface PIN ENA to Pin Output of MCU to control the operation by oneself.
- 5) Provide +5V Power Supply for Board ET-MINI ISD2548.
- 6) MCU sends the first Data set $0xFC0$ for Initial ISD2548; in this case, it is Bit A5-A0 according to BIT Data in the table above. It is normally set to be '0' first ('1' is used to choose the format of operation); Bit A8-A6 is set to be '1' to set ISD2548 to run in Push-Button Mode; and Bit \overline{CE} , PD, P/ \overline{R} is set to be '1' for Initial ISD2548 to be in status of Reset.
- 7) MCU sends the second Data set $0xBC0$ (PC = 0); it releases ISD2548 from status of Reset but other rest Bits are still the same.
- 8) MCU sends the third Data set $0x1C0$ (\overline{CE} , PD, P/ \overline{R} = 0); it sends Clock Pulse Low to Pin \overline{CE} of ISD2548; moreover, it sets ISD2548 to run in Record mode but Other rest Bits are still the same.
- 9) MCU sends the forth Data set $0x9C0$ (\overline{CE} = 1); it sends Clock Pulse High to Pin \overline{CE} of ISD2548 but other rest Bits are still the same. After sent this Data set, it starts recording. The normal status of Pin \overline{EOM} is Low becomes High that shows the status of recording. In this case, it starts recoding at Address $0x000$.
- 10) If it stops recording, MCU re-sends the Data in step No.8 and 9, respectively (in this case, it sends another one wave of Signal Clock Pulse to stop recording), it stops recording instantly. Signal at Pin \overline{EOM} is changed from High from Low that shows the status of stop recording (user always checks this signal before start re-record). It does not clear any Address Pointer of the memory after it stops recording (If it does not reset ISD2548).
- 11) Referred to step No.10 above; if user would like to record more message, MCU sends Signal Clock Pulse again according to the Data in step No.8 and 9 respectively, it starts recording again. The new message is recorded after the first message and it automatically assumes to be the second

message, it is not the first message. When user sends the Data in step No.8 and 9 alternatively, the operation alternates between record and stop alternatively. It continues recording messages until the memory of ISD2548 is filled to capacity. Remember, each message that is continuously recorded is always the new message, it is not the continuous message set.

- 12) When user would like to start recording new message at the Address 0x000 again, it has to return step No.6 and reset the new Initial ISD2548.

Referred to sending the Data in step 8 and 9 above, it is easier to record if using Push-Button Switch; it is interfaced with MCU and checks the status of pressing switch. If the switch is pressed, MCU sends out the Data in step No.8-9 and user can record any data while pressing SW. When the switch is released from pressing, MCU sends out the Data in step No.8 and 9 to stop recording. Moreover, it always checks if Signal EOM becomes '0' because it shows that ISD2548 stops recording completely.

5.3.2) Procedures for Playback

- 1) Interface I/O (OUTPUT-PIN) of MCU with Pin Din, SCK, STR of Board ISD2548.
- 2) Interface I/O (INPUT-PIN) of MCU with Pin EOM of Board ISD2548 (EOM of this Mode is used to show the status of operation).
- 3) Interface headphone or amplifier at Connector SP.
- 4) Set Jumper JP1 to the side of GND to Enable Shift Register 74HC595; or, if user would like to control Enable by MCU by oneself, it has to set Jumper JP1 to the side of ENA and then interface PIN ENA with Pin Output of MCU to control the operation.
- 5) Provide +5V Power supply for Board ET-MINI ISD2548.
- 6) MCU sends the first Data set 0xFC0 for Initial ISD2548; in this case, it is Bit A5-A0 according to BIT Data in the table above. It is normally set to be '0' first ('1' is used to choose the format of operation); Bit A8-A6 is set to be '1' to set ISD2548 to run in Push-Button Mode; and Bit CE, PD, P/R is set to be '1' for Initial ISD2548 to be in status of Reset.
- 7) MCU sends the second Data set 0xBC0 (PD = 0); ISD2548 exits from the status of Reset but other rest Bits are still the same.
- 8) MCU sends the third Data set 0x3C0 (CE = 0); it sends Signal Clock Pulse Low to Pin CE of ISD2548 but other rest Bits are still the same.
- 9) MCU sends the fourth Data set 0xBC0 (CE = 1); it sends Signal Clock Pulse High to Pin CE of ISD2548 but other rest Bits are the same. After sent this Data set, it starts playback at Address 0x000; the status of Pin EOM that is normally Low becomes High that shows the status of Playback. When it finishes playing a message, it stops automatically; moreover, the status of Pin EOM is changed from High to Low that shows the status of finish ends. User always checks this signal before starting playback the next message.
- 10) Refer to step No.9 above; when it finishes playing any message and it already checked that the status of Signal EOM becomes Low, it automatically stops. When user would like to play the next message, MCU sends new Data according to Step No.8 and 9 above; in this case, it sends Signal Clock Pulse Low to High to Pin CE of ISD2548, the message after the first message will be played instantly. Every time user sends Signal Pulse Low to High to Pin CE after the end of playing the previous message, the next message always plays. It plays until overflows happens; or, Pin PD becomes High (Reset ISD2548), it resets the Address Pointer to Address 0x000. So, if user would like to start play back at Address 0x000, it has to return step No.6.
- 11) While it is playing message incompletely, MCU can send Data in step No.8 and 9 that is Signal Clock Pulse Low to High to Pin CE of ISD2548, it temporarily stops (PAUSE) and Address Pointer is not reset. Moreover, the signal at Pin EOM changes from High to Low when it is in the status of

PAUSE. If user requires exiting from the status of PAUSE, it has to re-send Data in step No.8 and 9; it returns to the paused position and plays.

6. Example Programs in CD-ROM

Examples that are provided in CD-Rom are written by C Language for MCU AVR-MEGA128, PIC18F8722, and 89C51RE2. User can read more Compiler and Circuit that supports each example from COMMENT above the program. In this case, Examples of each MCU are the same. User should prepare following devices for testing the operation of each program;

- *1. Board MCU version ET-BASE AVR ATmega128 r3 or CP-JR51RE2 V1.0 or ET-BASE PIC8722(ICD2)
- *2. Board ET-MINI ISD2548
- 3. LCD 16x2 + ET-CONV14LCD (for the example 1,2,3)
- 4. TEST INPUT (Push Button Switch for the example 1,3,4)
- 5. ET-MINI DS3232 (for the example 2)

***It is compatible with all examples.**

Ex. ADDRESS MODE

Ex1_Play_Record: This example is used to record and playback. First of all, it has to interface LCD, SW and Board ET-MINI ISD2548 (Set JP1 = GND, JP2 = choose connected channels between MIC and ANA IN) with Board MCU completely. When user interfaces circuits according to the COMMENT above the program completely, user can load program to test instantly. This example can record each message not longer than 1.2 seconds and it can choose any preferable channel to record and playback. Firstly, user should press SW+ or SW- to choose any preferable channel to record; in this case, user can see number on LCD Display that will be changed according to pressing SW (Default = Message 01); next, it presses SW.RECORD, it starts recording instantly. While recording, the LCD Display also shows message REC[(0)] and the number 0 in the parenthesis is blinking. After 1.2 seconds completed, the program exits from the status of RECORD instantly and LCD Display shows the value before start recording. Next, user should press SW.PLAYBACK to listen to the recorded message. When user requires recording other message, it only presses SW+, SW- to choose the new channel if user does not to record by overlapping the old channel. The SW.PLAY ALL is used to play back all recorded messages; in this case, it starts playing back from the message in the first channel.

Amount of channel that is used to record depends on the length of time that user has divided; in this case, it is totally 48 seconds for all channels, according to the existing memory of ISD2548. The method to find out the initial Address of each channel is shown by formula in section No.4 above; user can record message correctly without overlapping.

Ex2_Tell_Time: This example is used to announce time every 30 minutes. Before using this example, user has to record data into ISD2548 first by using Program and interface circuit as described in the example 1, and then record message into Channel Message 02-19. In this case, user can see COMMENT above the program of the example 2 to see what message is stored in each channel; file messages are provided in CD in the Folder "ตัวอย่างเสียง_Rec/ข้อความบอกเวลา". When it records, it can interface signal in the Socket Headphone of PC with Connector ANA IN of Board ET-MINI ISD2548 directly and it sets Jumper PJ2 to the side of ANA IN as well. After it recorded message completely, it has to interface circuit of the example 2 according the COMMENT above the program (when interfacing circuit, it has to remove all Power Supply from circuit, otherwise the recorded message may be lost); next, user loads the example program 2 to test. It sets the time of this example as 11:29:55. When the

program starts running and the time of LCD Display reaches 11:30:00, it says "Ka na nee wae la sip ed na li ka sam aip na tee soon wee na tee". It always says every 30 minutes. The feature of running this program is to read time value from RTC and then it uses the time value that is read in each time to check the operation. If uses the time value in the part of second to check if it is equal to 00; if yes, it checks if the value of minute is equal to 30 or 00. If the value of second and minute is under existing conditions, it starts playing message in each channel, according to the current time value. It plays the message in each channel continuously.

Ex3_Ticket: This example is used to announce ticket number for each counter service that presses switch; in this case, there are 6 counter services and it can announce 99 ticket numbers in the range of 01-99. Before testing this example, user has to record data into ISD2548 first; it uses Program and interfaces circuit according to the example 1; next, it records message into Channel Message 02-24. In this case, user can see COMMENT above the program of the example 3 to see what message is recorded in each channel; the file messages that are provided in CD-ROM in Folder "ตัวอย่างเสียง_Rec/ข้อความบัตร

คิว". When it records message, it can interface signal in the Socket Headphone of PC with Connector ANA IN of Board ET-NINI ISD2545 directly; moreover, it has to set Jumper JP2 to the side of ANA IN. After recorded message completely, it has to interface circuit of the example 3 according to COMMENT above the program (when interfacing circuit, it has to remove all Power Supply from the circuit, otherwise all recorded messages may be lost); next, it loads the example program 3 to test the operation. When the program starts running, it shows the message "COUNTER = " and "NUMBER = " on the LCD Display. When user presses any switch on the screen, it also shows the Counter number according to the switch position that is pressed and it shows the ticket number; moreover, it says "choen mai lek... tee chong bo ri kan... kha". Every time user presses this switch, it always says this sentence. In the part of the Counter Number, it always says according to any switch number from 1 to 6 that is pressed. In the part of Ticket Number, it always runs continuously from 01-99 and it says the number after the previous number.

Ex. PUSH BUTTON MODE

Ex4 Play Record skip: This example is used to record and playback. First of all, it has to interface SW. and Board ET-MINI ISD2548 (Set JP1 = GND, JP2 = choose the channel that is interfaced with MIC or ANA IN) with Board MCU first. After interfaced the circuits according to COMMENT above the program completely, user can load the program to test the operation. The feature of running program is described as follows;

- **Record:** User has to press and hold SW.Record, it starts recording at Address 0x000. When this SW. is released, it stops instantly; and it finishes recording the first message. If user does not press SW.Reset and user does not press and hold the SW.Record again, it starts recording new message; in this case, the second message will be recorded after the first message instantly. If user has not pressed SW.Reset yet and capacity of the memory is not full, the message that is recorded in each time will be arranged in order, respectively.

- **Playback:** User has to press SW.Play and then releases, it starts playing back from the first message. When it finishes, it stops automatically. When user presses SW.Play again, the next message after the first message will be played. It continues playing back messages until user presses SW.Reset or it is the last message in the memory, it stops automatically. Every time user presses SW.Play, it always plays messages in order, according to pressing SW.Play.

- **Skip:** When user presses and releases SW.Skip in each time, it skips forwards one message. For example, if it starts playing the first message and user presses SW.Skip one time and then presses SW.Play, the second message starts playing instantly, not the first message.

- **Reset:** Every time user presses SW.Reset, the Address Pointer internal ISD2548 is reset to be '0'. So, when user presses SW.Play or SW.Record after pressing SW.Reset, it always restarts playing the first message; and it restarts recording at the position of the first message as well.

