Winbond Electronics Corporation America

VOICE DSP

ISD-T360 Reference Design User's Guide

For Digital Answering Machines

INCLUDED IN THIS REFERENCE DESIGN

INTRODUCTION

Information Storage Device's digital speech processor (DSP), the ISD-T360, provides digital answering machine (DAM) functionality and full-duplex speakerphone capabilities to embedded systems by integrating the function of traditional DSP and a 16-bit, general purpose, RISC core. The DSP interfaces directly with codec circuitry and flash memory under the control of the ISD-T360 processor, through a serial MICROWIRE interface. Thus, the DSP operates as a slave peripheral that receives commands from the external master Winbond 89C51 processor. The ISD-T360 combined with a 16-Mbit flash memory device can provide up to one hour of recording time.

The Winbond 89C51 is an 8-bit microcontroller providing 36 I/O pins for sufficient interfacing with analog other than DSP circuitry. The processor manages all of the I/O pins and time facilities throughout the entire system.

This reference design guide provides a basic working model for designing, constructing and operating a fully-functional DAM using the ISD-T360 VoiceDSP processor. All required information is contained in these pages and on the attached disk. If additional support is required, please email our product support department at apps@isd.com.

FEATURES

This reference design for a DAM using the ISD-T360 digital speech processor not only contains basic answering machine features but also offers the following additional features:

- Features full-duplex speakerphone functionality
  - Hands-free conversations between user and line user
- Supports 16m flash memory devices
  - Samsung flash
  - Interchangeable design possibilities
- Utilizes ISD's International Vocabulary System (IVS) synthesized speech application to generate voice prompts during operation
  - Supports multiple languages
- Includes digital volume control for speakers
- Allows total remote control capabilities
- Operates at low power when idle

SCHEMATIC DIAGRAMS

The following schematic diagrams detail layout designs for the ISD-T360-based DAM.

Figure 1: Microphone and speaker circuitry

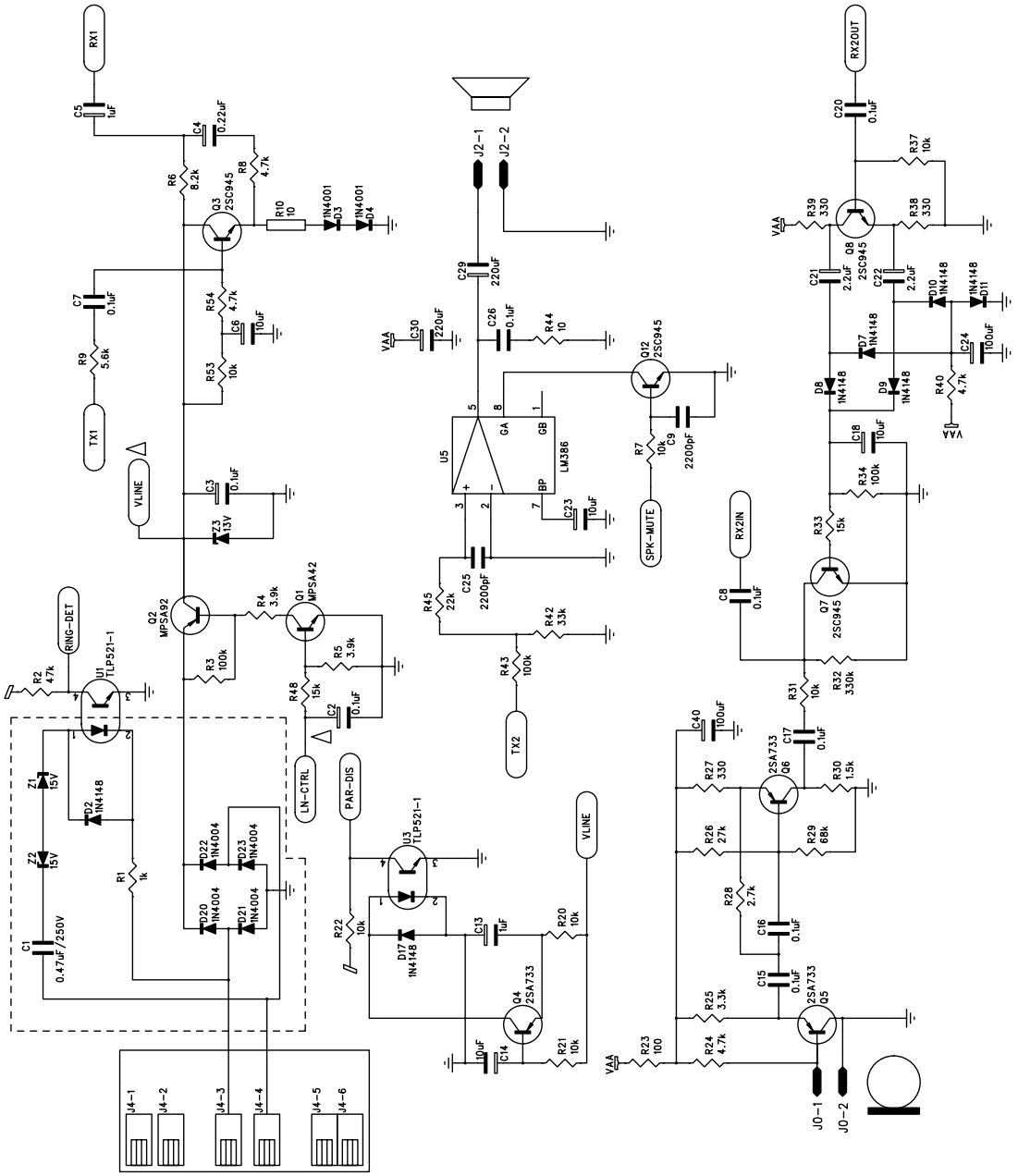


Figure 2: CODEC Interface

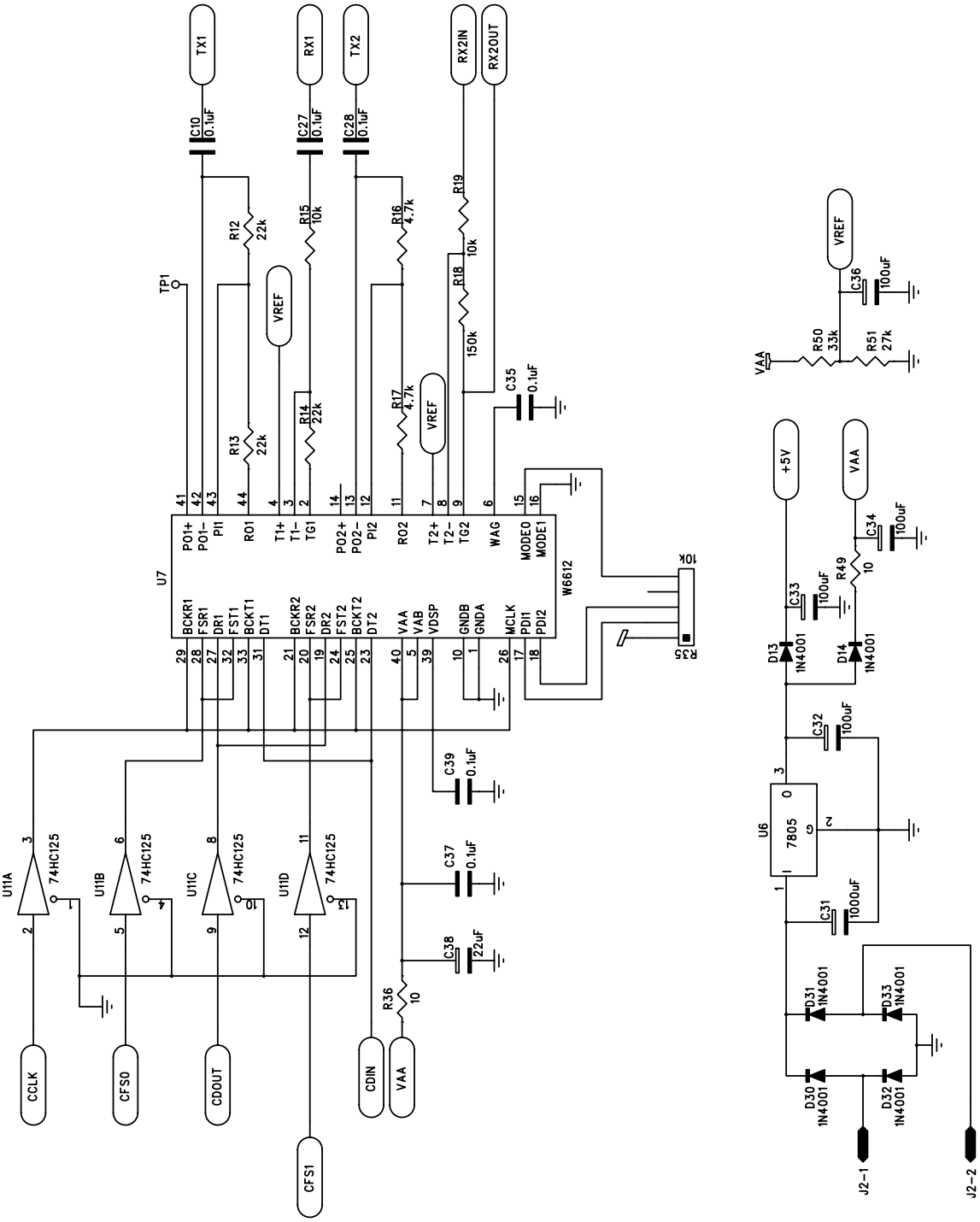


Figure 3: Microcontroller I/O assignments

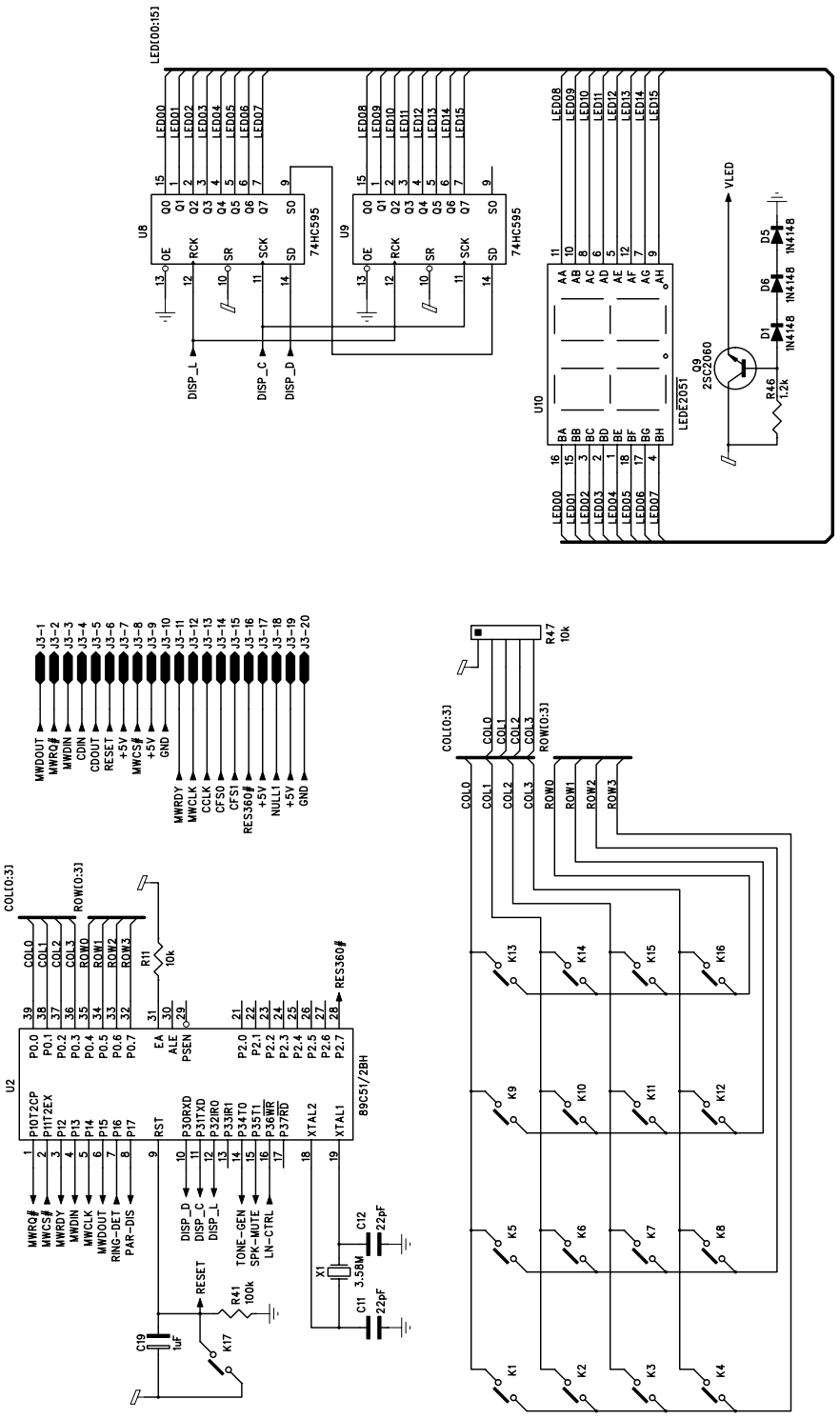
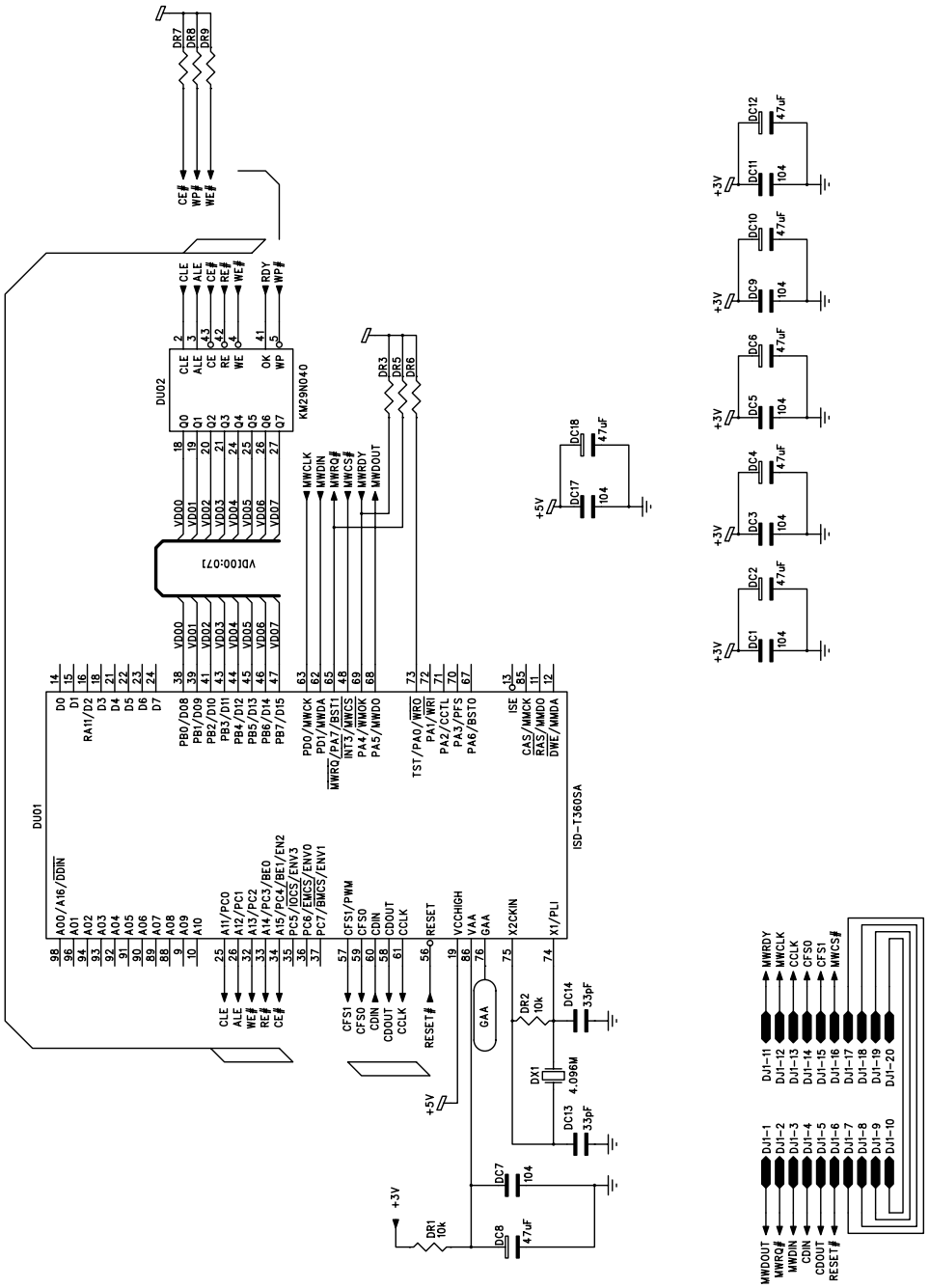


Figure 4: Memory Interface



FLOW CHARTS FOR THE ISD-T360 DAM REFERENCE DESIGN

T360 REFERENCE DESIGN S/W STRUCTURE

The reference software code is written in C language for 8051microcontroller. It has a small kernel and is easily integrated into an 8051-based system's software, such as Telephone Set, Caller ID systems, Cordless Phone and PABX systems.

The software is comprised of three components:

1. Kernel
2. Device driver
3. Answer machine as the state machine

Each of these components are detailed below.

Kernel

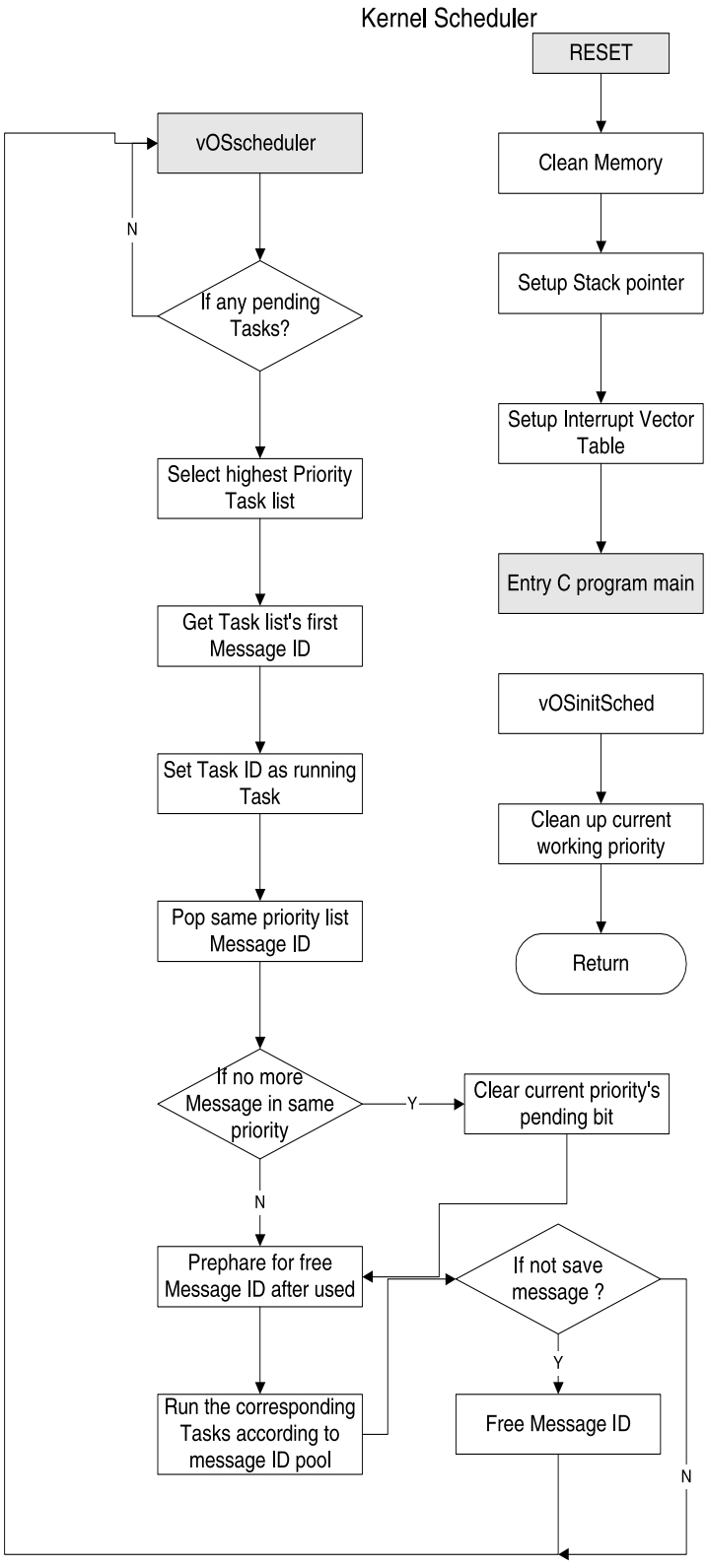
- Timer: the timer has 6 software timers, which can start by any task and timeout to wake up any other task.
- Message Handler: the message handler has 10 message handlers for passing information between tasks. Each message has a 1-byte message header and 2-bytes of data. This can be easily increased by modifying the "include" file.
- State Machine table: each task can setup its own state machine table. The Kernel's state controller will search corresponding task's state machine table to find the correct message header, then run the routine.

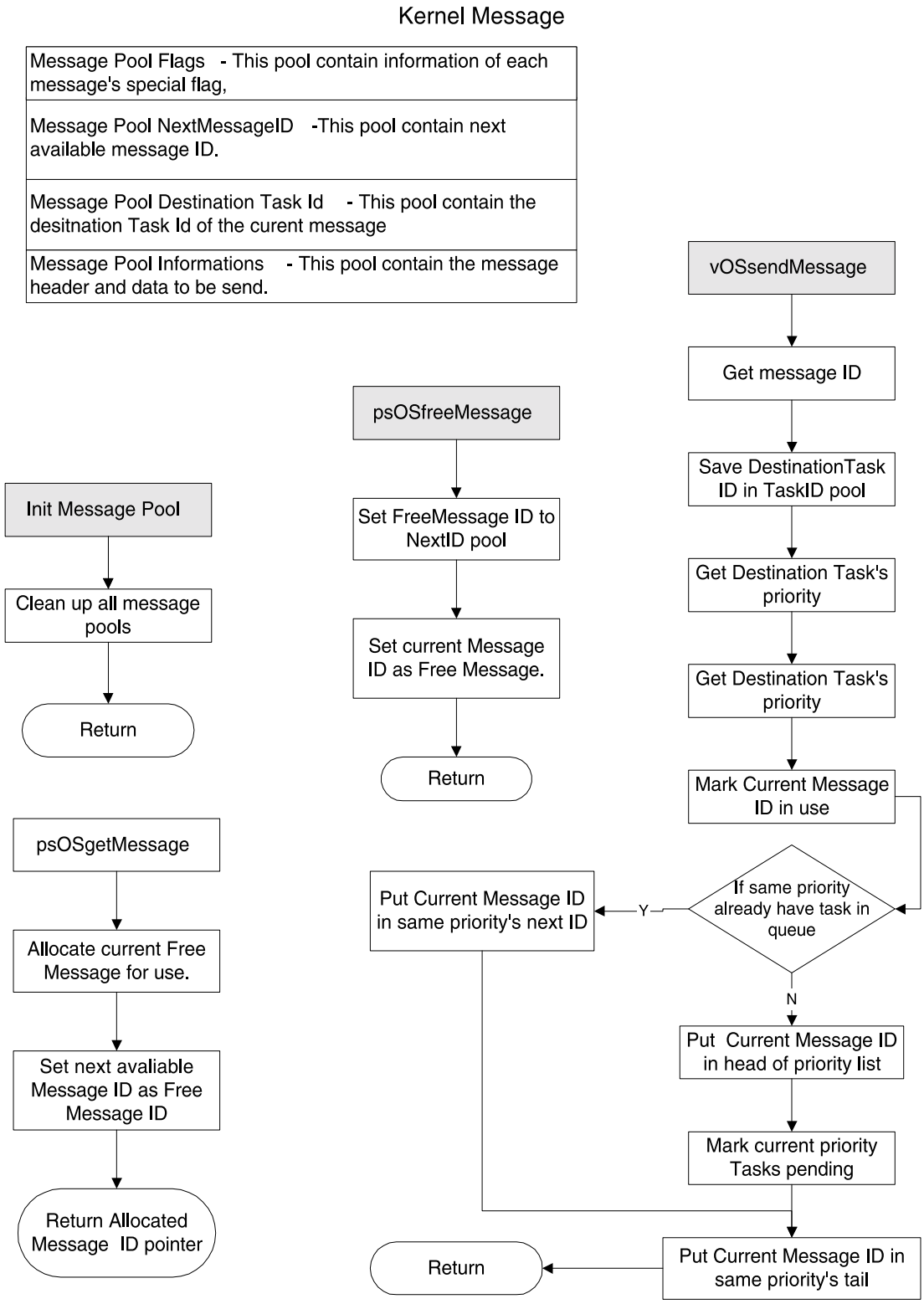
Device Driver

- T360 driver: this driver includes microwire interface and commands sent to or received from T360.
- Ring Detection: detects one ring pattern and then sends a ring event to the Answer machine module. This detection may vary in some countries, thus requiring modification on the timing of this module.
- LED: sends data out to I/O pin for two 7-segment LED display.
- KEY: scans the Key matrix and converts it to the corresponding key function required for Answer machine module.
- 8051 driver: controls other I/O pins, such as on/off hook, speaker mute on/off.

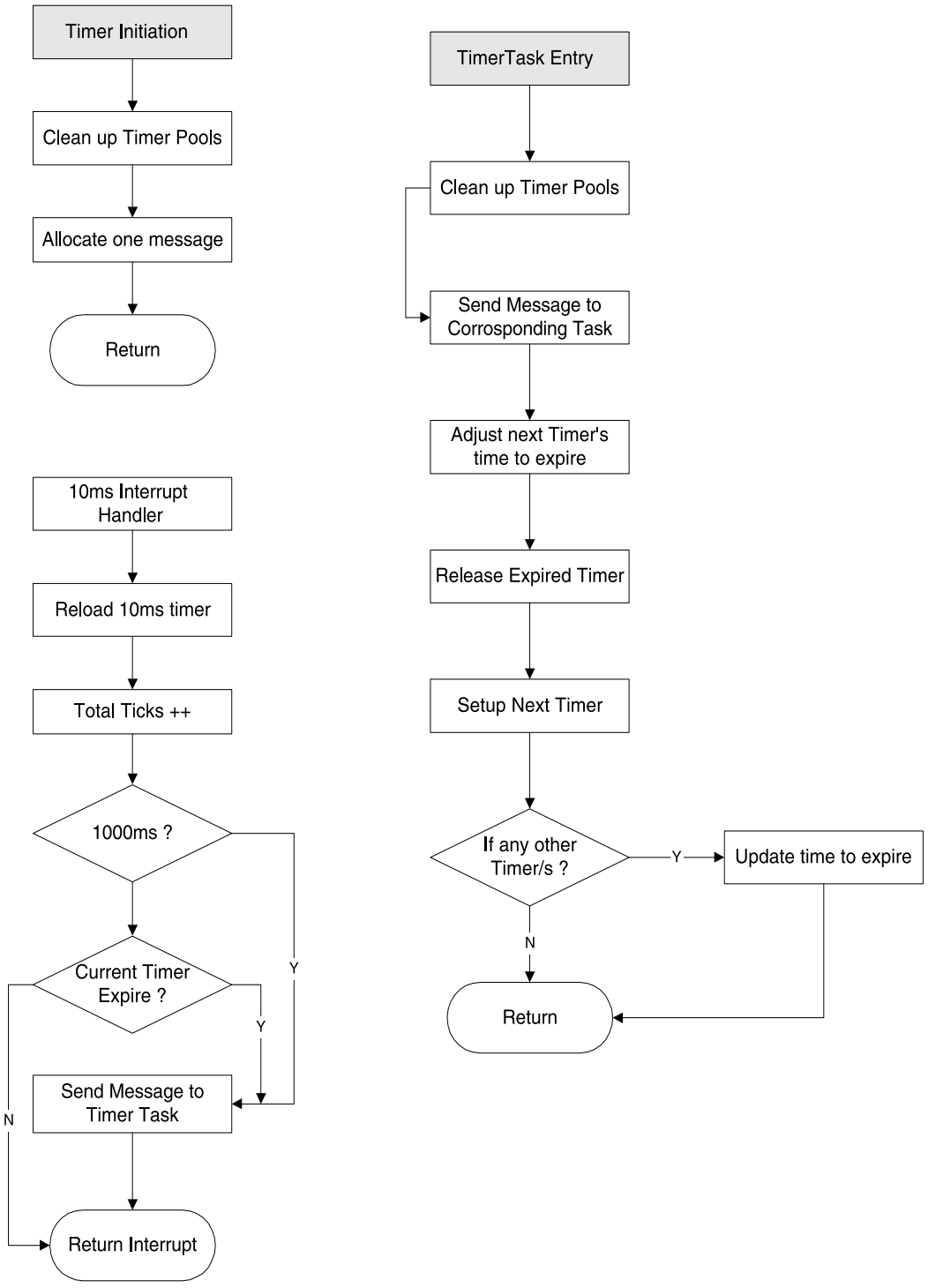
Answer machine state Machine

- TADmain: includes the state machine table; details of the state flow follow in the next section.
- TAD function: includes functions called by the state machine such as Autoplay message, Play one Message, Recording, Delete one message, Delete all messages, etc.
- TAD set: includes entry and exist of setting mode, and updates system information such as CLOCK setting, Security Code setting, Answer On/Off option, etc.

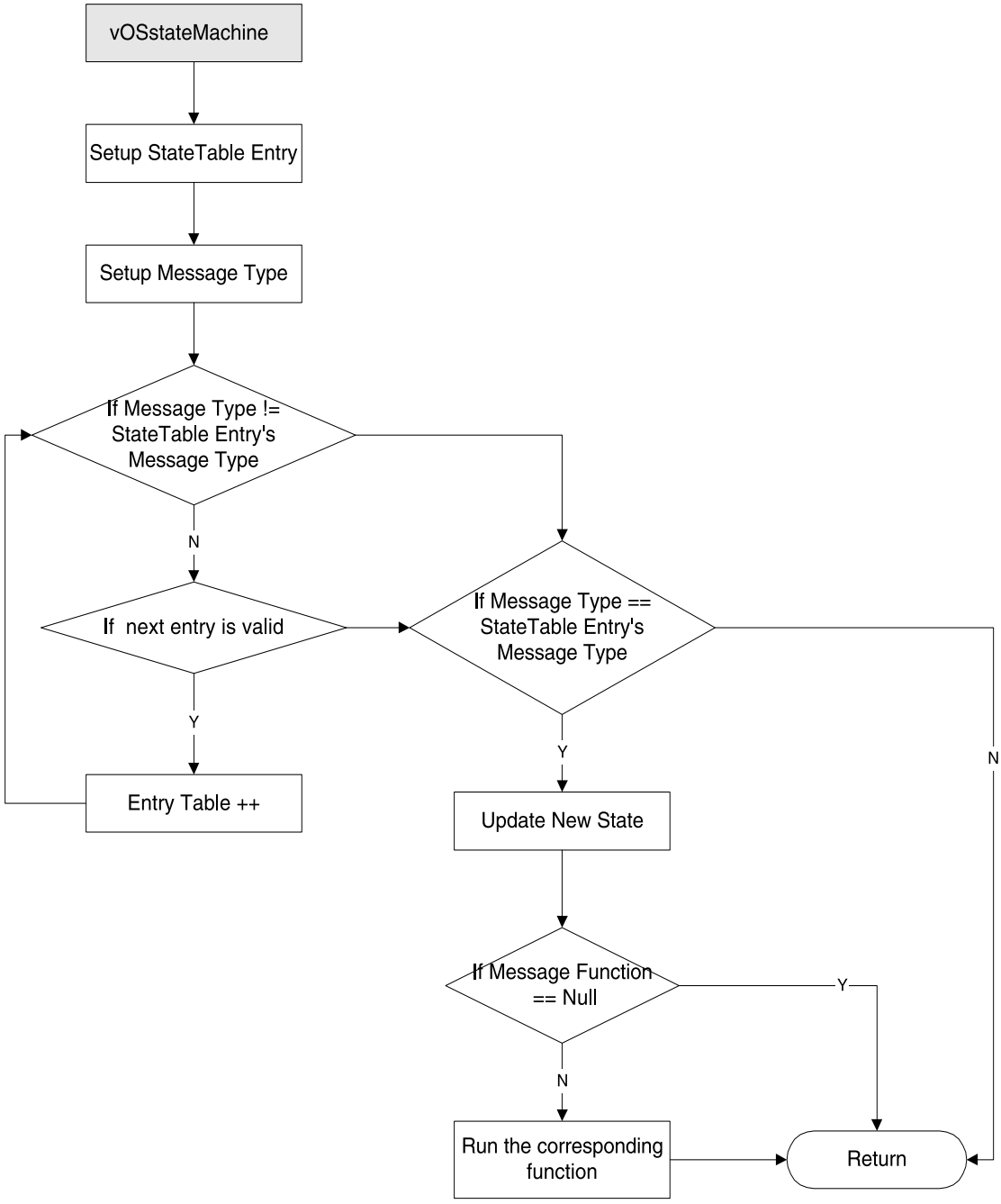

Kernel Scheduler
RESET
Clean Memory
Setup Stack pointer
Setup Interrupt Vector Table
Entry C program main
vOSinitSched
Clean up current working priority
Return
vOSscheduler
N
If any pending Tasks?
Select highest Priority Task list
Get Task list's first Message ID
Set Task ID as running Task
Pop same priority list Message ID
If no more Message in same priority
Y
Clear current priority's pending bit
N
Prephare for free Message ID after used
If not save message ?
Y
Run the corresponding Tasks according to message ID pool
Free Message ID
N


Kernel Message
Message Pool Flags - This pool contain information of each message's special flag,
Message Pool NextMessageID -This pool contain next available message ID.
Message Pool Destination Task Id - This pool contain the desitnation Task Id of the curent message
Message Pool Informations - This pool contain the message header and data to be send.
vOSsendMessage
Get message ID
Save DestinationTask ID in TaskID pool
Get Destination Task's priority
Get Destination Task's priority
Mark Current Message ID in use
If same priority already have task in queue
Y
Put Current Message ID in same priority's next ID
N
Put Current Message ID in head of priority list
Mark current priority Tasks pending
Put Current Message ID in same priority's tail
Return
psOSfreeMessage
Set FreeMessage ID to NextID pool
Set current Message ID as Free Message.
Return
Init Message Pool
Clean up all message pools
Return
psOSgetMessage
Allocate current Free Message for use.
Set next avaliable Message ID as Free Message ID
Return Allocated Message ID pointer

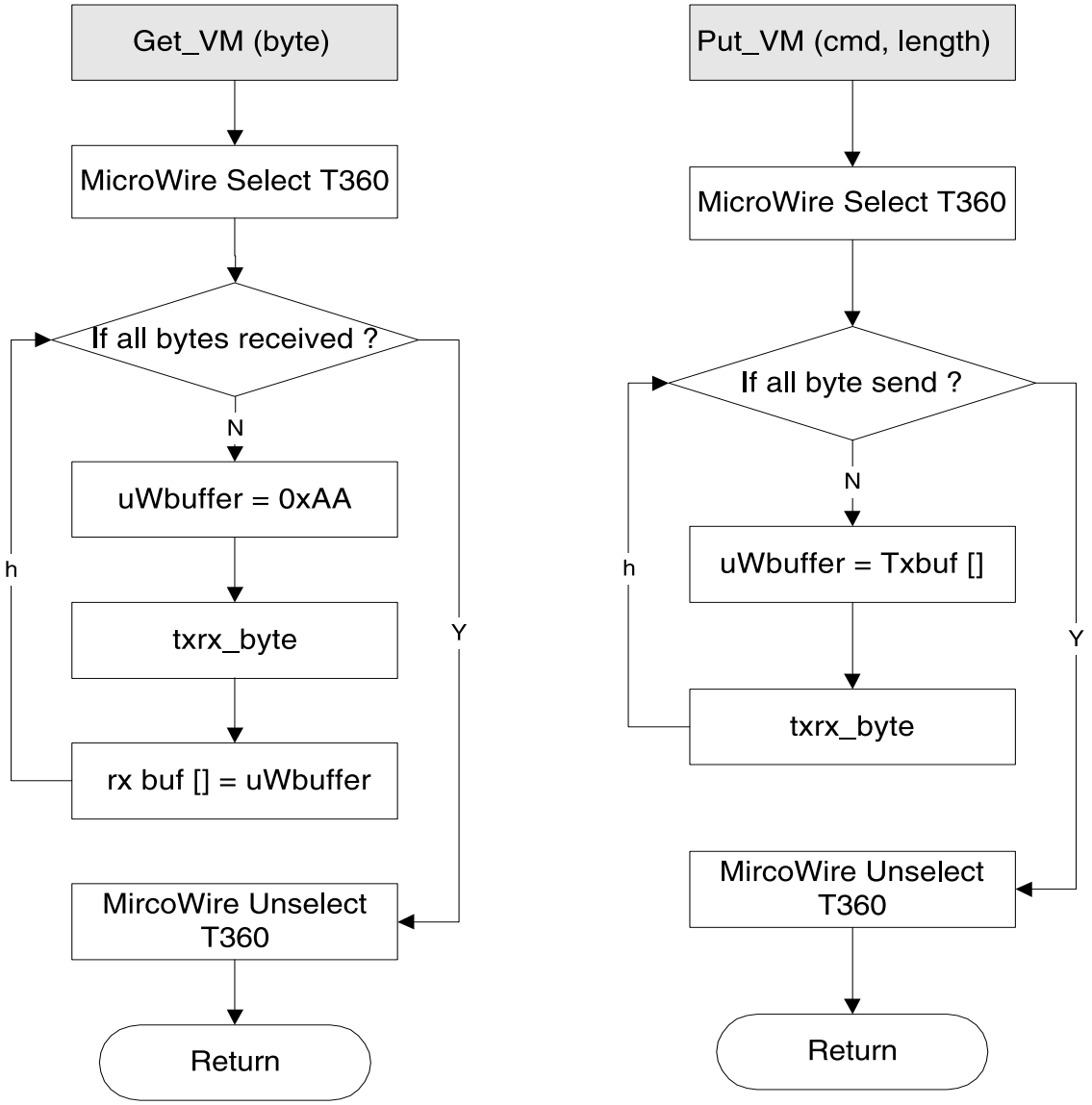
Kernel Timer

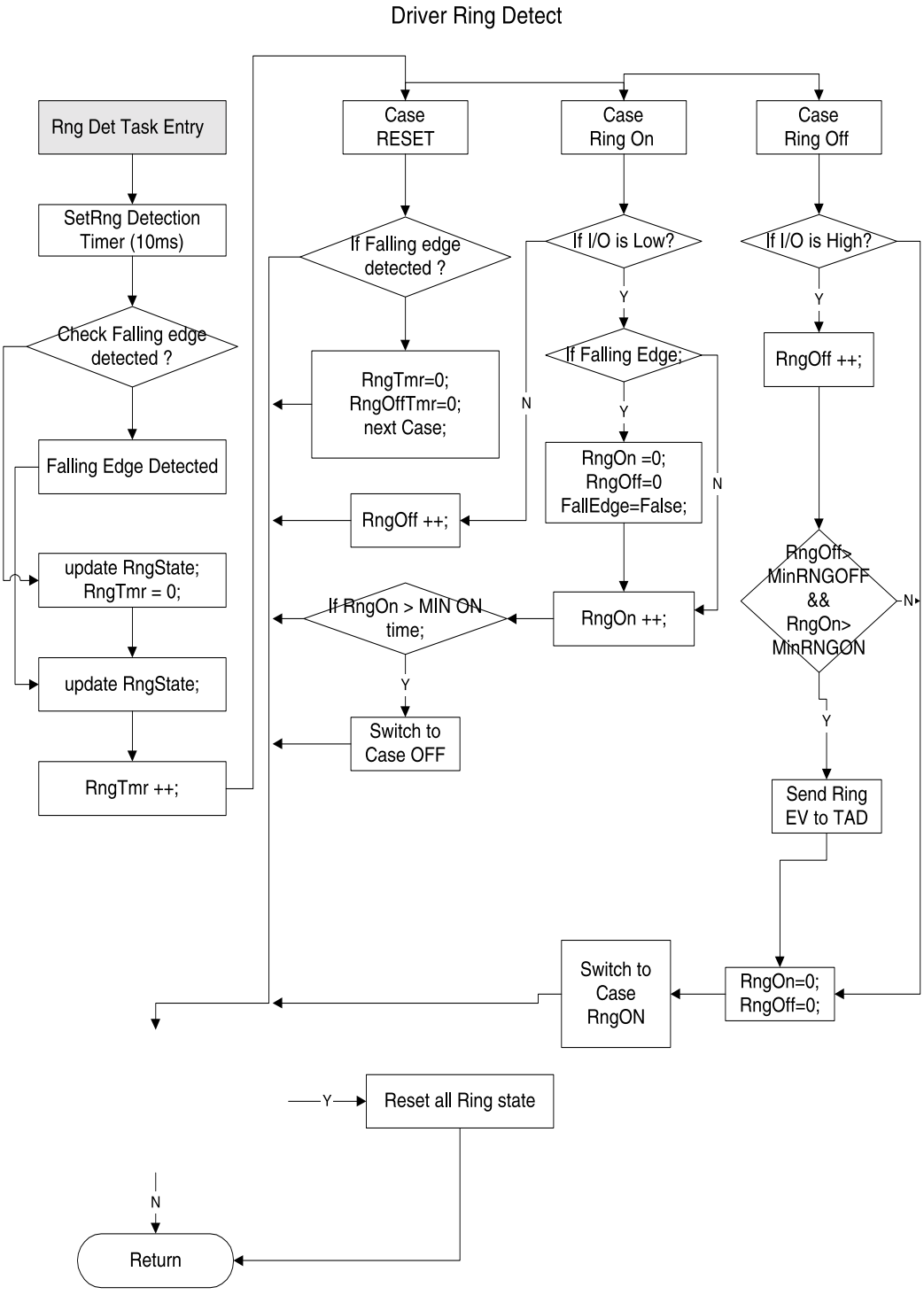


Kernel State machine

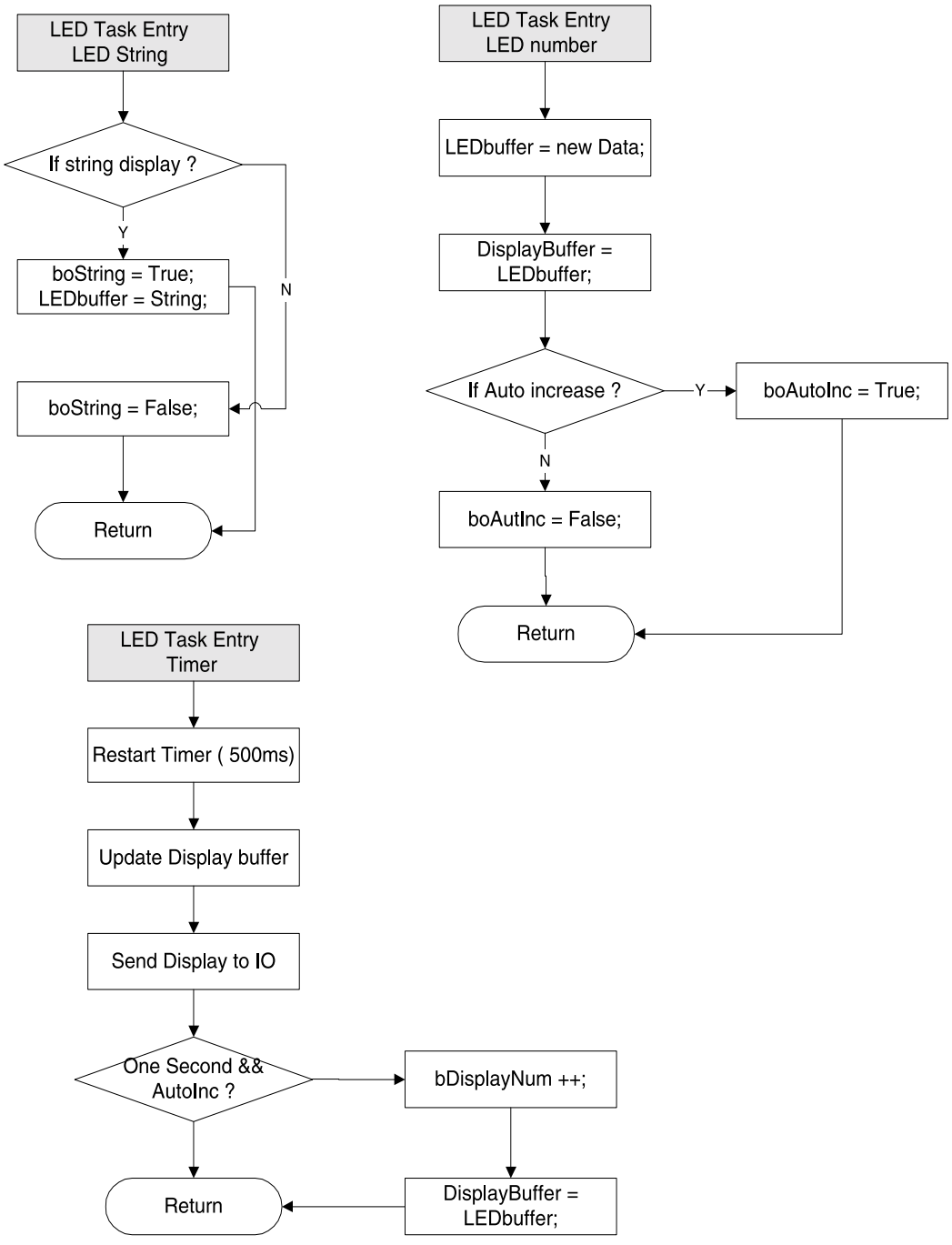


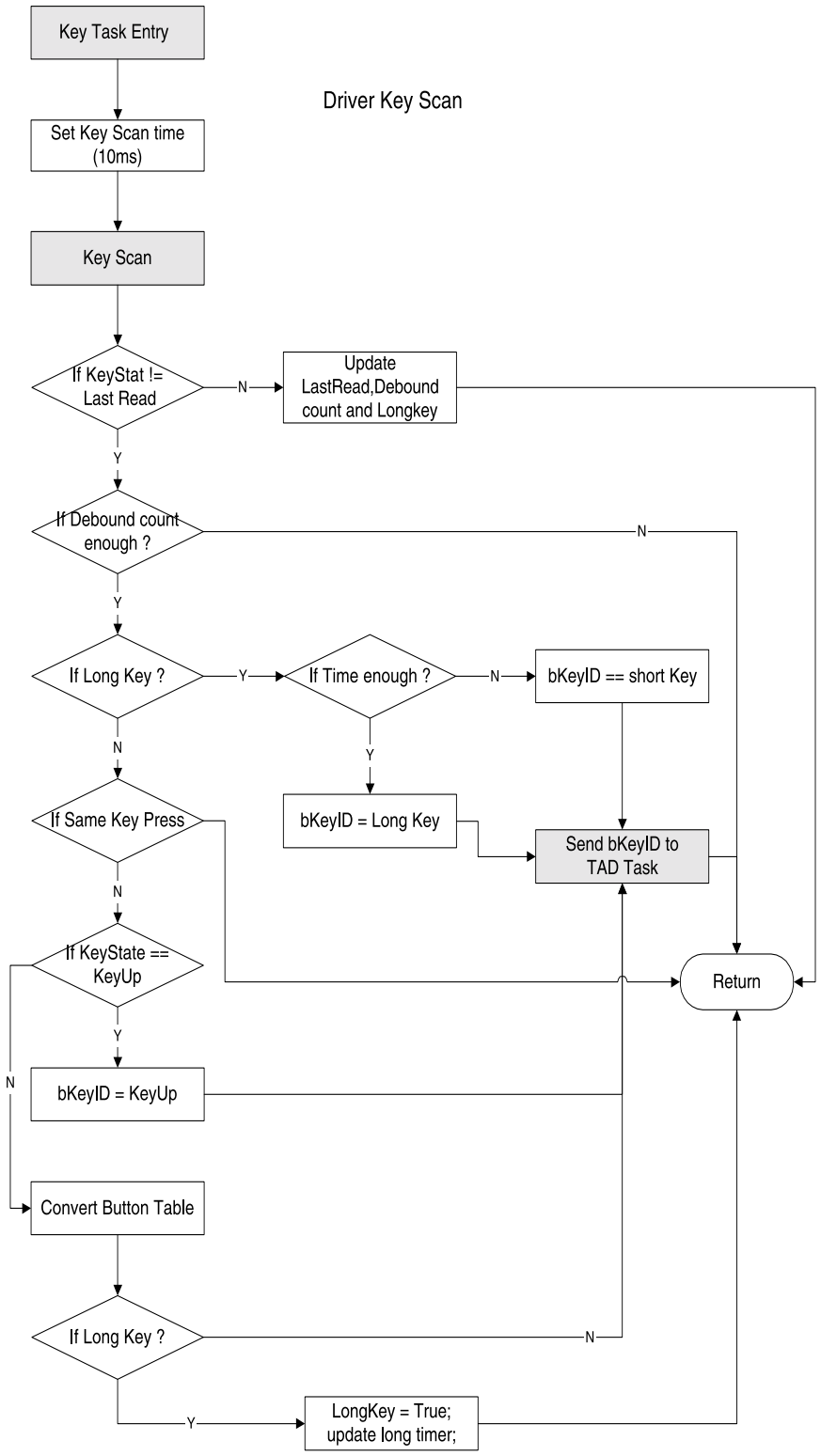
Driver T360

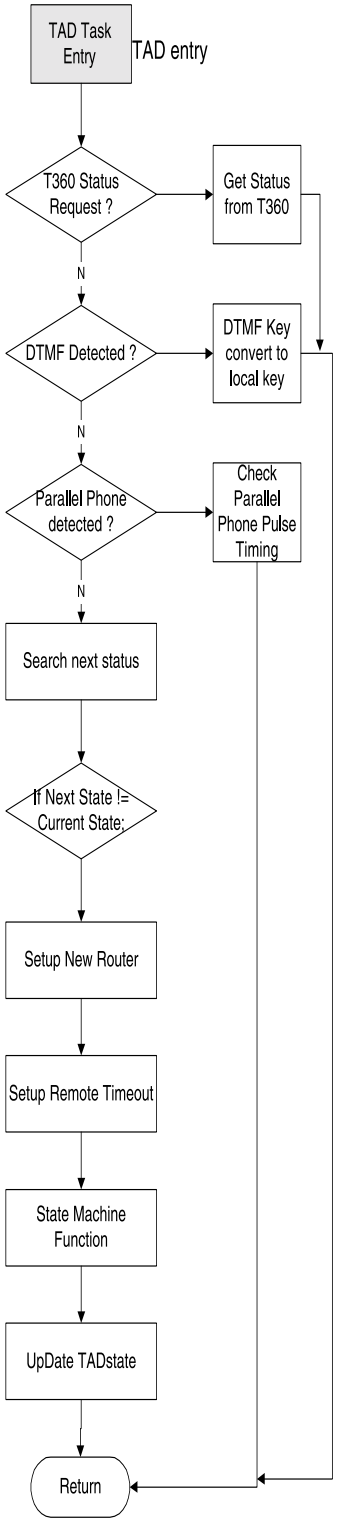

Get_VM (byte)
MicroWire Select T360
If all bytes received ?
N
uWbuffer = 0xAA
txrx_byte
rx buf [] = uWbuffer
h
Y
MircoWire Unselect T360
Return
Put_VM (cmd, length)
MicroWire Select T360
If all byte send ?
N
uWbuffer = Txbuf []
txrx_byte
h
Y
MircoWire Unselect T360
Return


Driver Ring Detect
Rng Det Task Entry
SetRng Detection Timer (10ms)
Check Falling edge detected ?
Falling Edge Detected
update RngState; RngTmr = 0;
update RngState;
RngTmr ++;
Case RESET
If Falling edge detected ?
RngTmr=0; RngOffTmr=0; next Case;
RngOff ++;
If RngOn > MIN ON time;
Switch to Case OFF
Case Ring On
If I/O is Low?
If Falling Edge;
RngOn =0; RngOff=0 FallEdge=False;
RngOn ++;
Case Ring Off
If I/O is High?
RngOff ++;
RngOff> MinRNGOFF && RngOn> MinRNGON
Send Ring EV to TAD
RngOn=0; RngOff=0;
Switch to Case RngON
Reset all Ring state
Return
Y
N

Driver LED


LED Task Entry
LED String
If string display ?
Y
N
boString = True;
LEDbuffer = String;
boString = False;
Return
LED Task Entry
LED number
LEDbuffer = new Data;
DisplayBuffer =
LEDbuffer;
If Auto increase ?
Y
boAutoInc = True;
N
boAutInc = False;
Return
LED Task Entry
Timer
Restart Timer (500ms)
Update Display buffer
Send Display to IO
One Second &&
AutoInc ?
bDisplayNum ++;
Return
DisplayBuffer =
LEDbuffer;

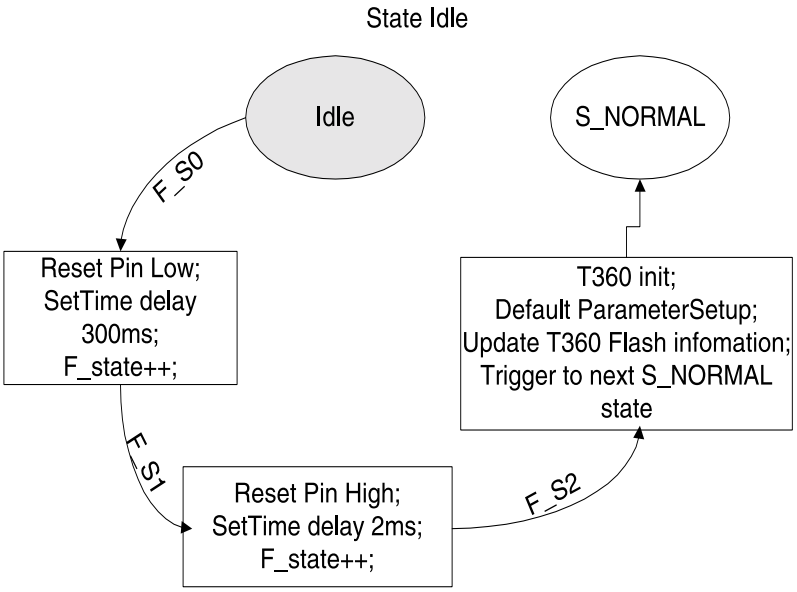

Key Task Entry
Driver Key Scan
Set Key Scan time (10ms)
Key Scan
If KeyStat != Last Read
N
Update LastRead,Debound count and Longkey
Y
If Debound count enough ?
N
Y
If Long Key ?
Y
If Time enough ?
N
bKeyID == short Key
N
Y
If Same Key Press
bKeyID = Long Key
Send bKeyID to TAD Task
N
If KeyState == KeyUp
Return
Y
N
bKeyID = KeyUp
Convert Button Table
If Long Key ?
N
Y
LongKey = True; update long timer;

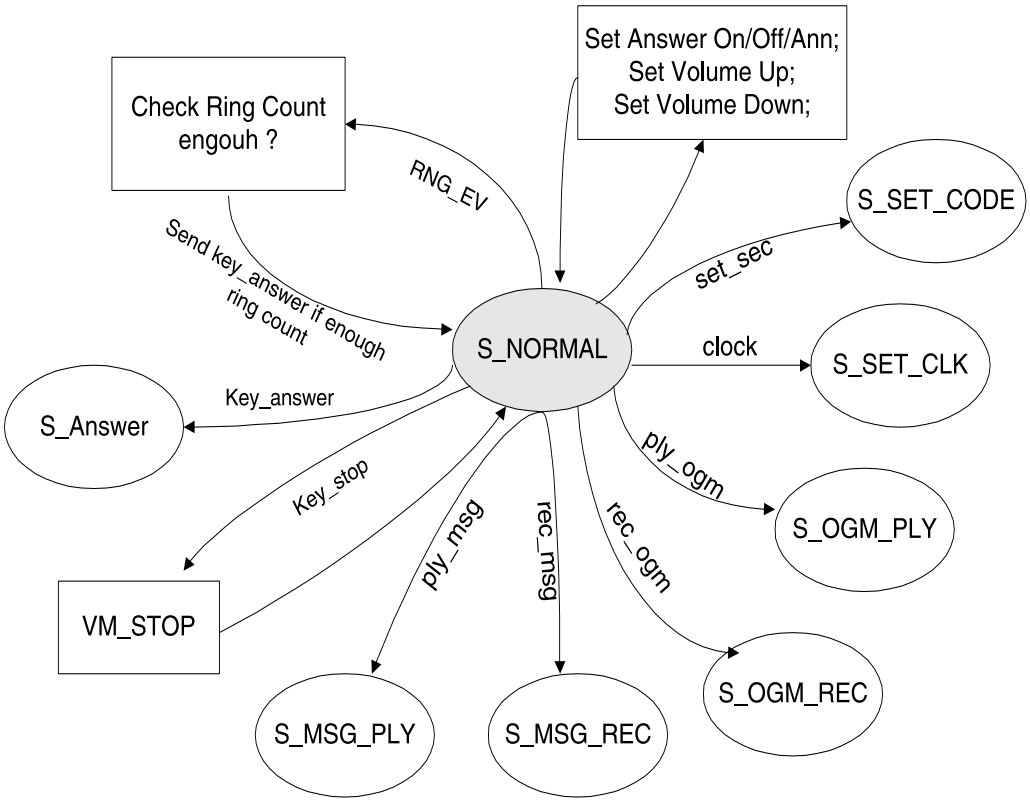

TAD Task Entry
TAD entry
T360 Status Request ?
Get Status from T360
N
DTMF Detected ?
DTMF Key convert to local key
N
Parallel Phone detected ?
Check Parallel Phone Pulse Timing
N
Search next status
If Next State != Current State;
Setup New Router
Setup Remote Timeout
State Machine Function
UpDate TADstate
Return

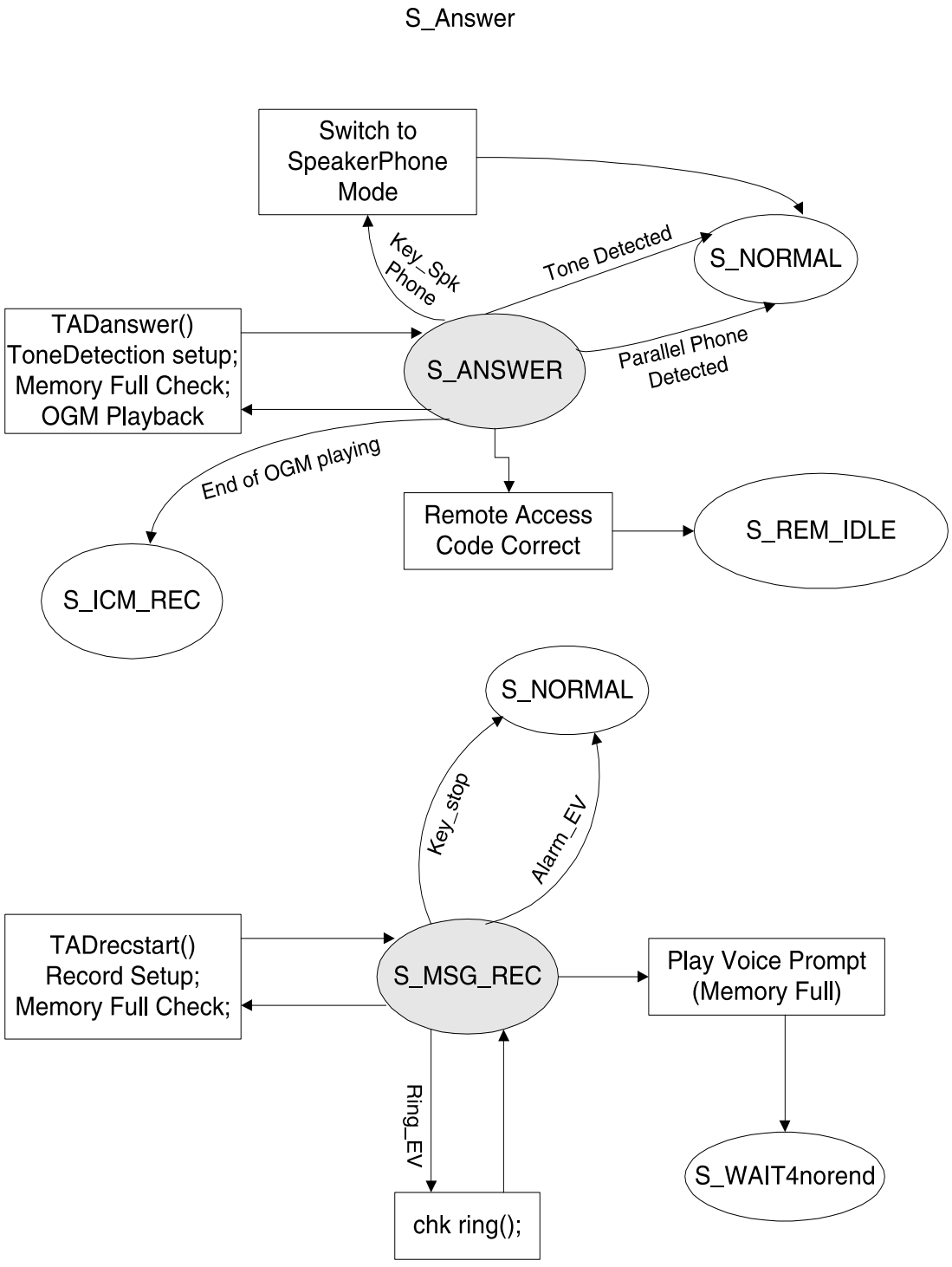
TAD State machine

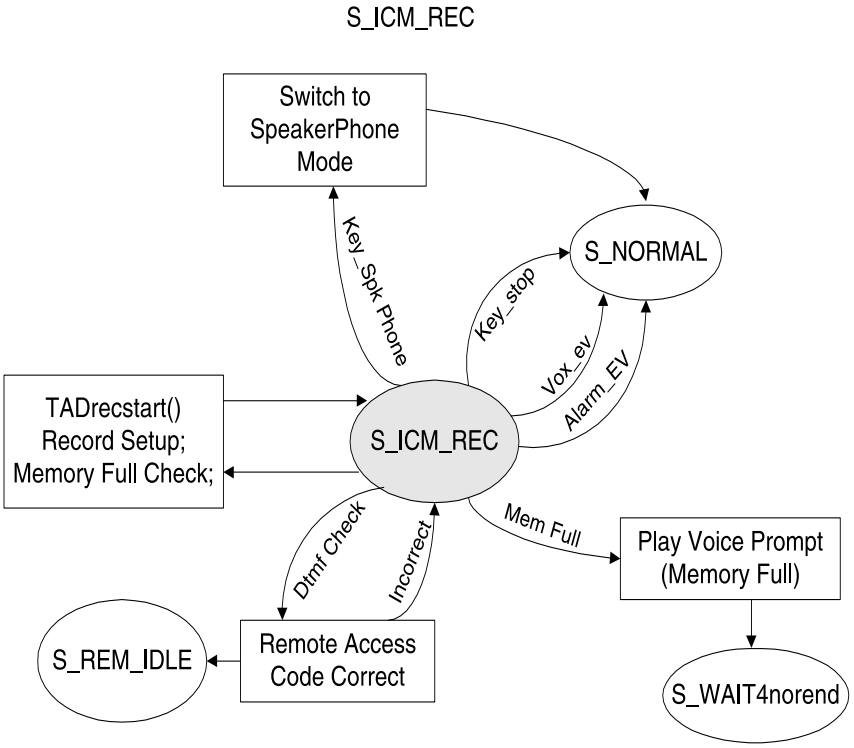
```
 asTADstateMachine[]= {
   asTADstateIdle,
   asTADstateNormal,
   asTADanswer,
   asTADmsgrec,
   asTADicmrec,
   asTADogmrec,
   asTADmsgply,
   asTADogmply,
   asTADsayclk,
   asTADsetsec,
   asTADremidle,
   asTADremmsgply,
   asTADremogmrec,
   asTADremogmply,
   asWAIT4norend
};
```

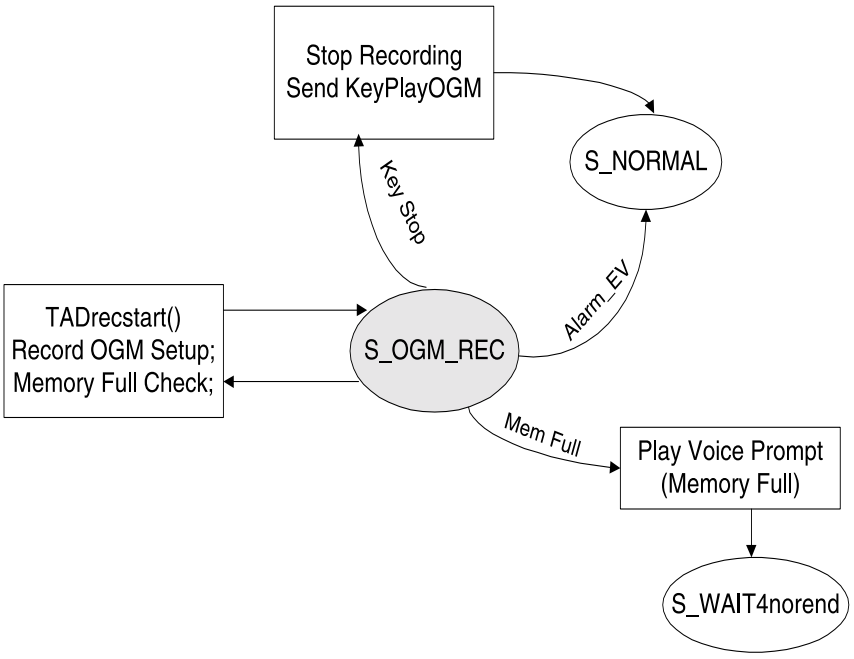
TADstateIdle: Idle status during power on
TADnormal: Status wait for Key input or Ring input
TADanswer: Enter this state when ring count is enough.
TADmsgrec:Recording message
TADicmrec:Recording ICM.
TADogmrec: Recording OGM.
TADmsgply: Automatic playback ICM/MEMO
TADplyogm:Playback single message (OGM)
TADsetclk:Setup Clock
TADsetsec:Setup Secuirty Code
TADremidle: Enter when correct security code input.
TADremmsgply:Remote playback ICM/Memo
TADremogmrec: Remote record OGM.
TADremogmply: Remote OGM playback
WAIT4norend: Wait for Normal end, (wait for voice prompt finish)

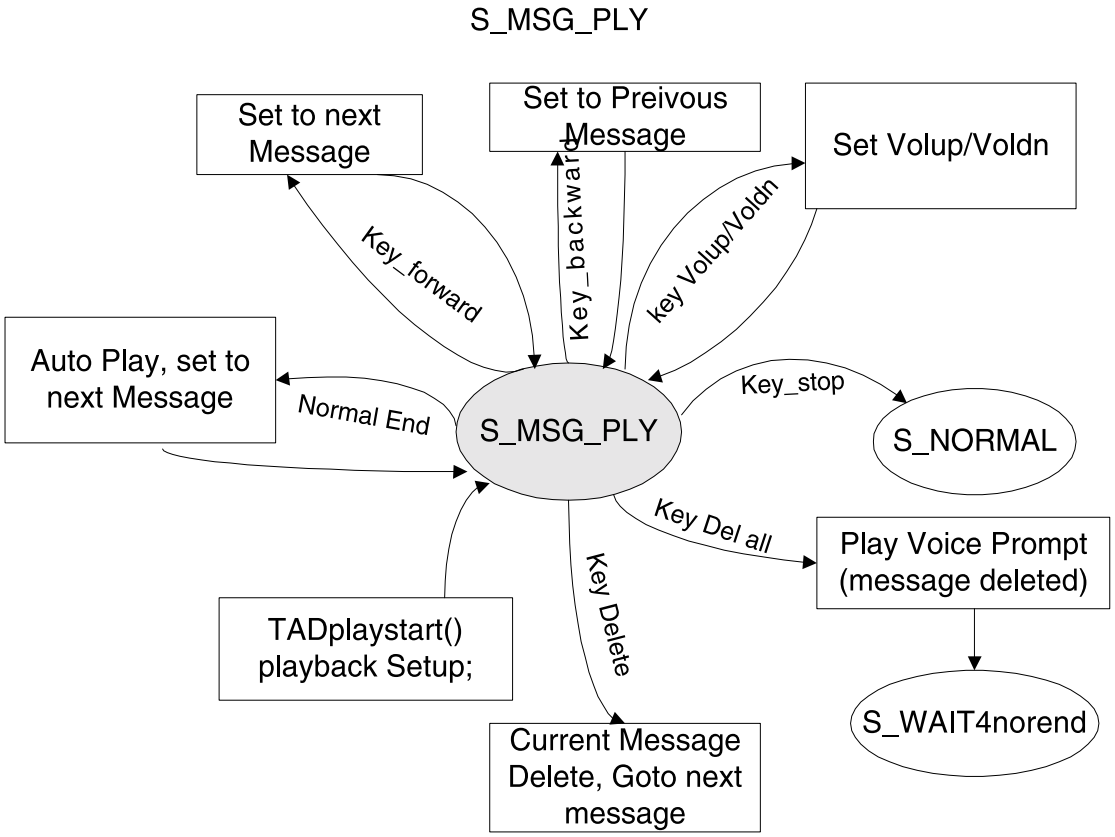

State Idle
Idle
S_NORMAL
F_S0
Reset Pin Low;
SetTime delay
300ms;
F_state++;
T360 init;
Default ParameterSetup;
Update T360 Flash infomation;
Trigger to next S_NORMAL
state
F_S1
Reset Pin High;
SetTime delay 2ms;
F_state++;
F_S2


Set Answer On/Off/Ann;
Set Volume Up;
Set Volume Down;
Check Ring Count
engouh ?
RNG_EV
Send key_answer if enough
ring count
S_SET_CODE
set_sec
S_NORMAL
clock
S_SET_CLK
S_Answer
Key_answer
Key_stop
ply_ogm
S_OGM_PLY
VM_STOP
ply_msg
rec_msg
rec_ogm
S_OGM_REC
S_MSG_PLY
S_MSG_REC


S_Answer
Switch to SpeakerPhone Mode
Key_Spk Phone
Tone Detected
S_NORMAL
TADanswer() ToneDetection setup; Memory Full Check; OGM Playback
S_ANSWER
Parallel Phone Detected
End of OGM playing
Remote Access Code Correct
S_REM_IDLE
S_ICM_REC
S_NORMAL
Key_stop
Alarm_EV
TADrecstart() Record Setup; Memory Full Check;
S_MSG_REC
Play Voice Prompt (Memory Full)
Ring_EV
S_WAIT4norend
chk ring();


S_ICM_REC
Switch to SpeakerPhone Mode
S_NORMAL
Key_Spk Phone
Key_stop
Vox_ev
Alarm_EV
TADrecstart() Record Setup; Memory Full Check;
S_ICM_REC
Dtmf Check
Incorrect
Mem Full
Play Voice Prompt (Memory Full)
S_REM_IDLE
Remote Access Code Correct
S_WAIT4norend


Stop Recording Send KeyPlayOGM
S_NORMAL
Key Stop
Alarm_EV
TADrecstart() Record OGM Setup; Memory Full Check;
S_OGM_REC
Mem Full
Play Voice Prompt (Memory Full)
S_WAIT4norend


S_MSG_PLY
Set to next Message
Set to Preivous Message
Set Volup/Voldn
Key_forward
Key_backward
key Volup/Voldn
Auto Play, set to next Message
Normal End
S_MSG_PLY
Key_stop
S_NORMAL
Key Del all
Play Voice Prompt (message deleted)
TADplaystart() playback Setup;
Key Delete
S_WAIT4norend
Current Message Delete, Goto next message

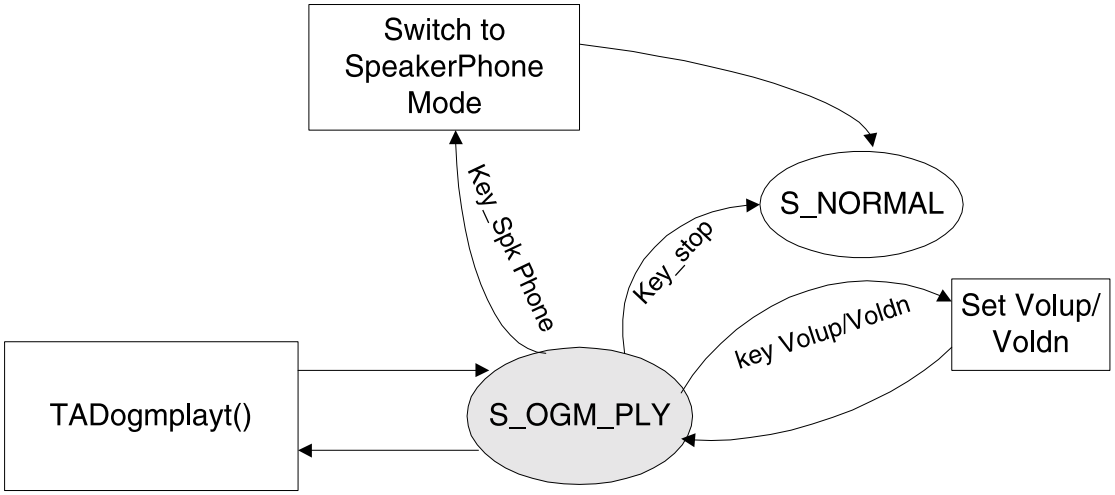

Switch to SpeakerPhone Mode
Key_Spk Phone
S_NORMAL
Key_stop
Set Volup/ Voldn
key Volup/Voldn
TADogmplayt()
S_OGM_PLY

TABLE OF SOURCE CODE FILES FOR THE ISD-T360 DIGITAL ANSWERING MACHINE REFERENCE DESIGN

FILE TYPE	FILE NAME	Description
Kernel	Startup.a51	Hardware reset entry point, Setup Interrupt vector table, clean up memory and entry to Main C program.
	Osmsg.c	Handle message information, pools and table between the tasks
	Ossched.c	Select the tasks to be run according to priority from message pools
	Osstate.c	According to current task, search corresponding message in different status, run the responding function then consume the message information.
	Ostimer.c	Under Interrupt timer kicks, if timeout occurs, send message to Timer Tasks. Timer Task rearranges timers and sends messages to corresponding Tasks.
	Task.c	Setup priority and function pointer for each Task
	Main.c	Tasks and hardware driver initialize and start infinite loop in scheduler
Driver	Drv360.c	Microwire interface. T360 command and parameter handling
	Drv8051.c	8051 I/O configure and I/O control
	Key.c	Key scans every 10ms and converts valid keys into corresponding key functions, then sends to TAD task
	Led.c	Led display driver
	Rngdet.	Ring detection
Tadcid	Tadfunc.c	Answer machine functions: recording OGM/MEMO, playback OGM/MEMO, Message delete, etc.
	Tadmain.c	TAD status machine table and TAD task entry
	Tadset.c	Functions of TAD parameter setting: Answer On/Off, ring count, Remote access code, etc.

OPERATING THE DAM

Once the power supply is connected, the 7-segment display will show "00" and play voice prompt "Initialization completed, ready for operation". The display will show one of the following states:

Display	Meaning
"No of ICM recorded"	DAM in "On" mode with ICM recorded
" An" / "no of ICM recorded" alternately	DAM in "An" mode with ICM recorded
"OF" / " no of ICM recorded" alternately	DAM in "OFF" mode with ICM recorded
"--" / "no of ICM recorded" alternately	no OGM nor ICM recorded

CLOCK, SETTING THE CLOCK

Check Time

Press the CLOCK button and the answering machine will say the current time (i.e., "Monday, 12:00 A.M.).

Set Clock

Press and hold the CLOCK button for more than one second. You will hear the voice prompt "set clock" and the answering machine will announce the current day and time (i.e., Monday, 12:00 A.M.). At the same time, the display will show the day ("01" for Sunday, "02" for Monday, etc.).

1. **Changing the Day.** By pressing the FWD or BWD buttons, the day will be increased or decreased, respectively, and the machine will simultaneously announce the current day. To confirm the setting, press and hold the CLOCK button within fives seconds of the announcement, and then the machine will enter the Hour Mode. Otherwise, the machine returns to the idle mode.
2. **Changing the Hour.** To change the hour, press the FWD or BWD buttons while in the Hour Mode (follows the Day Mode) and the hour will be increased or decreased, respectively. Note that the display will show the hour from 00 to 23, while the machine will announce the hours 1 to 12 with A.M. or P.M. To confirm the setting, press and hold the CLOCK button; the machine then enters the Minute Mode. Otherwise, the machine returns to idle mode.
3. **Changing the Minute.** To change the minute, use the FWD and BWD buttons as explained above in updating the hour and day. To confirm the setting, press the CLOCK button within five seconds of the announcement. Read the updated clock and exit Set Clock Mode.

NOTE: The clock settings will not be saved and the system will return to the idle state if no key is pressed after five seconds - unless, STOP is pressed during any mode or CLOCK is pressed while in the minute setting mode.

THE RING SELECT BUTTON

Press the RNG_SEL button to display the current ring setting. Press and hold the RNG_SEL button, and the LED display will show one of the following messages:

[r2] — The answering machine responds after second ring.

[r4] — The answering machine responds after fourth ring.

[rA] — If there are previously recorded messages, the answering machine responds after the second ring. Otherwise it responds after the fourth ring.

SETTING SEC (SECURITY CODE)

SEC (Security Code) numbers must start with a "9". Thus the code numbers are "9ab" or "9xy" where the "ab" and "xy" are the user's input numbers.

To set the SEC, press the CODE button until the LED display shows "CS" and "ab", alternately (current code number). By pressing the CHANGE button, the machine will display the current SEC code. Increase the left digit by pressing the BWD button and the right digit by pressing the FWD button. To confirm the setting, press CODE within five seconds. The machine will display "9ab". If the CODE button is not pressed within five seconds, the answering machine will return to idle with the SEC remaining unchanged.

OGM, RECORD AND PLAYBACK

Record an OGM (Out-Going Message)

You must record the outgoing message prior to entering the Answer/Announce mode. Otherwise, the machine will not record any Incoming Messages.

To record an OGM, press and hold the OGM button until the beeps sound. The DAM will begin to record and the LED displays the elapsed time of the OGM. When recording is finished, press the STOP button. The machine will playback the OGM and return to idle state. Note that the recording will be terminated if it exceeds 60 seconds in duration.

Playback an OGM

To playback an OGM, press the OGM button once. Increase or decrease the volume by pressing the VOL_UP or VOL_DN button, respectively. To halt the playback, press the STOP button. If no OGM was previously recorded, the DAM will beep twice and the LED will display "--". After playback the DAM will return to idle.

SETTING ANSWER ON/ OFF/ANNOUNCE ONLY

Setting Answer On

Press the ON/OFF button until the voice prompt "Answer on" sounds and the LED displays a 2-digit number, which represents the number of ICM (In-Coming Messages). In this mode, the answering machine will record all incoming calls until memory is full (maximum 50 calls).

Setting Answer Off

To set the Answer Off, press the ON/OFF button until the voice prompt "Answer off" sounds and the LED displays "OF". In this mode the DAM will not answer any in-coming calls. The LED will display "OF" and the number of ICMs, alternately.

Setting the Announce Only

To set the Announce Only, press the ON/OFF button until the voice prompt "Announce only" sounds and the LED displays "An". In this mode, the answering machine will answer the incoming call and play the OGM, but will not record an incoming message. The LED will display "OF" and number of ICMs, alternately.

TO PLAY THE ICMS (INCOMING MESSAGES)

When a new ICM is recorded, the New Message LED lights up. To play the ICM, press the PLAY button. The DAM will begin playing the earliest ICM and progress to the latest ICM. Simultaneously, the 7-segment display will show the number of the current message being played. After ICMs are played, the New Message LED will automatically turn off.

While the ICM is Being Played, It Is Possible to:

Feature	Buttons
Replay the current message	Press the BWD button while the message is playing
Pause/Resume current message	Press the PLAY button to toggle between Pausing and Resuming the message.
Stop playing an ICM	Press STOP button
Erase the current ICM	While playing the message that you want to delete, press the ERASE button
Skip to next ICM	Press FWD button
Go to previous ICM	Press BWD button
Adjust volume	Press the VOL_UP or VOL_DN button to increase the volume accordingly

TO ERASE ALL ICMS (INCOMING MESSAGES)

While in idle mode, press and hold the ERASE button until you hear the long beep indicating that all incoming messages have been erased.

NOTE: An incoming message will not be erased if it was not previously played.

TO RECORD A MEMO

To record a memo, press and hold the MEMO button until the voice prompt "Memo Recording" is announced. The DAM begins recording the message and the 7-segment display lists the elapsed time. When you are finished recording, press the STOP button. The machine will return to the idle state. Note that the recorded memo will be treated as an ICM by the DAM and can be played during ICM playback.

SPEAKER PHONE

To enable the speakerphone, press the SPK button. Press the SPK button again to toggle the speakerphone off.

ACCESSING THE DAM REMOTELY

All remote control functions must be operated through a DTMF-tone telephone. To access the remote functions, call and wait until the DAM answers, and the OGM plays. Key-in the three digit security code (see Setting the SEC) while the OGM is playing or the ICM recording.

To Playback an ICM, Remotely

After entering the correct security code, two beeps will sound and the DAM will wait seven seconds for a command. If nothing is entered, the DAM will disconnect. If the security code is incorrect, the DAM will continue recording your call as an ICM.

To playback all ICMs, press "0" once and the DAM will announce "You have <number of> message(s)." Once all ICMs have been played, the DAM will announce "End of messages." To repeat an ICM, press "0" again within six seconds and all ICMs will begin to playback.

Remote Volume Control

To adjust volume control during remote ICM playback, press "2" to increase volume or "1" to decrease volume.

Remote Erase of an ICM

To erase a current ICM, press "*" after ICM has finished playing. To erase all ICMs, press "*" for at least one second after *all* ICMs have finished playing.

Remote Save of an ICM

Once all the ICMs have been played, hang up. The DAM will automatically save all ICMs and continue to record new, incoming calls.

Remote Setting of DAM On, Off, or Announce only modes

While the OGM is playing or the ICM is recording, you can perform the following functions:

- Turn on the DAM: press "9" until three beeps sound, indicating the machine is in answer mode. Then press "4" to confirm the setting. Four beeps will sound for acknowledgment.
- Turn off the DAM: press "9" until two beeps sound, indicating the machine is off. Then press "4" to confirm the setting. Four beeps will sound for acknowledgment.
- Set DAM to Announce only: press "9" until one beep sounds, indicating the machine will only play the OGM and cease to record ICMs. Then press "4" to confirm the setting. Four beeps will sound for acknowledgment.

IMPORTANT NOTICES

The warranty for each product of ISD (Information Storage Devices, Inc.), is contained in a written warranty which governs sale and use of such product. Such warranty is contained in the printed terms and conditions under which such product is sold, or in a separate written warranty supplied with the product. Please refer to such written warranty with respect to its applicability to certain applications of such product.

These products may be subject to restrictions on use. Please contact ISD, for a list of the current additional restrictions on these products. By purchasing these products, the purchaser of these products agrees to comply with such use restrictions. Please contact ISD for clarification of any restrictions described herein.

ISD, reserves the right, without further notice, to change the ISD VoiceDSP product specifications and/or information in this document and to improve reliability, functions and design.

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The 100-year retention and 100K record cycle projections are based upon accelerated reliability tests, as published in the ISD Reliability Report, and are neither warranted nor guaranteed by ISD.

Information contained in this ISD VoiceDSP data sheet supersedes all data for the ISD VoiceDSP products published by ISD prior to August, 1998.

This data sheet and any future addendum to this data sheet is (are) the complete and controlling ISD VoiceDSP product specifications. In the event any inconsistencies exist between the information in this and other product documentation, or in the event that other product documentation contains information in addition to the information in this, the information contained herein supersedes and governs such other information in its entirety.

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