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SERIAL INTERFACE PRODUCTS

Using the ISD33000 Device with a Low-Cost Motorola Microcontroller

ISD application note "Using the ISD33000 with a Microcontroller," described code written for the COPS family of microcontrollers to do basic record and playback in the ISD33000 device series. The ISD-ES302 demo board uses that microcontroller and runs the listed software in that application note.

This application note describes how the Motorola 6805 series of microcontrollers may be used to perform the same function. Specifically, the attached code runs in a MC68HC705J1A 20 pin device and plugs into the ISD-ES302 demo board via an adapter board. Only one change was made on the ISD-ES302 board; the addition of a diode. The adapter board and ISD-ES302 modification are described following the software discussion. Much of this design is covered in the section "Using the ISD33000 with a Microcontroller," refer to it for the main board schematic and related explanations. The flow chart for the software is essentially the same for both notes and will not be repeated.

The main difference between the code in the previous application note and this one is that the COPS processor has a hardware SPI port and the MC68HC705J1A Motorola microcontroller does not. This software, therefore, has routines written to replace the hardware SPI port.

MAJOR SOFTWARE ROUTINES

The list file of this software will be broken up into pieces and each routine described. Many notes can also be found in the software listing itself. An unassembled source file of this software is available as an E-mail attachment from ISD Applications Department. Send a request to apps@isd.com and ask for the Applications Note No. 3 Source code.

Program Set Up and Listing Header

This software was assembled using a 6805 cross assembler purchased from 2500 A.D. Software.

```
2500 A.D. 6805 Macro Assembler—Version 4.01b
               ------------------------------------------------
                       Input  Filename : DEMO1.ASM
                       Output Filename : DEMO1.obj
    1      LIST ON
    2      PL 120
    3*************************************************************
    4*This Software is Copyright 1996 by Information Storage Devices
    5*
    6  * ISD
    7*
    8*
    9*
   10*
```

```
11*  *****        ********   *     *         *****
12*  *     *      *          **    **       *      *
13*       *      *     *          * *   * *      *      *
14*      *      *     *****      *  *  *  *     *      *
15*     *      *     *          *   * *   *    *      *
16*    *      *     *          *    **    *   *      *
17*   *******      ********   *     *     *    *****
18*
19*
20*
21*
22*
23*
24;*************************************************************************
25;*   ISD33000  D E M O      P R O G R A M                                  *
26;*                                                                         *
27;*                                                                         *
28;*    (C) 1996 I N F O R M A T I O N   S T O R A G E   D E V I C E S      *
29;*                                                                         *
30;*                                                                         *
31;*      MICROCONTROLLER      : MC68HC705J1A                                *
32;*      DATE OF LAST REVISION: 06.03.96                                    *
33;*      NAME OF SOURCE FILE  : demo1.asm                                   *
34;*      CLOCK SPEED          : 3.579545 MHz                                *
35;*
36;*************************************************************************
37;*************************************************************************
38
39                          *
40                          *
41                          *
42                          *
43                          *
44                                 LIST ON
45
```

Microcontroller pin out and I/O definition, register definition: The following shows the pin out of the microcontroller and defines the device I/O. It also defines the memory map and interrupt vectors as well as the control registers used in the device.

```
46   0000                       .ABSOLUTE
47                          ************************************************************
48                             *Port Definitions       MC68HC705J1A DIP or SOIC Package
49                             *PORT A
50                          ************************************************************
51          0000               porta    equ     0
52          0040               portaDDR equ     %01000000
53
54          0000               L2       equ     $00     pin 18 - Go to Begin pushbutton
55          0001               L5       equ     $01     pin 17 - Skip to Next pushbutton
56          0002               L6       equ     $02     pin 16 - Play Next pushbutton
57          0003               L1       equ     $03     pin 15 - REC pushbutton
58          0004               L4       equ     $04     pin 14 - STOP pushbutton
59          0005               RAC      equ     $05     pin 13 - Row Address Clock Input
```

```
 60          0006            LOWBAT  equ     $06     pin 12 - LED control output
 61          0007            L7      equ     $07     pin 11 - Play Last pushbutton
 62                          *
 63                        ************************************************************
 64                          *PORT B
 65                        ************************************************************
 66          0001            portb    equ     1
 67          001F            portbDDR equ     %00011111
 68
 69          0000            PD      equ     $00     pin 8  - PD pin to ISD2500
 70          0001            PLAREC  equ     $01     pin 7  - PLAY/REC pin to ISD2500
 71          0002            SSBAR   equ     $02     pin 6  - Slave Select SPI Output
 72          0003            SK      equ     $03     pin 5  - SPI Clock output
 73          0004            SO      equ     $04     pin 4  - Serial Out
 74          0005            SI      equ     $05     pin 3  - Serial In
 75                          *
 76                        ************************************************************
 77                          * Other Pin definitions
 78                        ************************************************************
 79                          *Pin 10 = VSS (GND)
 80                          *Pin 20 = RESET\ (active low)
 81                          *Pin 19 = IRQ\ ISD33000 Interupt output
 82                          *Pin  9 = VCC (+5)
 83                          *Pin  1 = OSC1
 84                          *Pin  2 = OSC2
 85
 86                          *SOFTWARE ASSUMES A 3.579545 MHz Crystal
 87                         *PERIOD IS .279365 uSEC, OR INTERNAL CLOCK OF .55873 uSEC PER
 88                          *CYCLE.                                          ------
 89                          *
 90                          *
 91                        ************************************************************
 92                          *area definitions
 93                         ************************************************************
 94          00C0            RamArea         equ     $00C0
 95          00FF            StkTop          equ     $00FF
 96          0300            RomArea         equ     $0300
 97          07F8            IntVects        equ     $07F8
 98                          *
 99
100                         ************************************************************
101                          *Vector area
102                        ************************************************************
103   07F8                        org     IntVects
104   07F8   0300                 fdb     TIMESVC
105   07FA   0302                 fdb     extsvc
106   07FC   0301                 fdb     swisvc
107   07FE   0324                 fdb     reset
108                         *
109                         *
110
111                         ************************************************************
112                          *Control Register Definitions
113                         ************************************************************
114 0008    TSCR    equ     $8      TIMER STATUS AND CONTROL REG
```

```
115          0009            TCR             equ     $9      TIMER COUNTER REGISTER
116          000A            ISCR            equ     $A      IRQ STATUS AND CONTROL
117          0010            PDRA            equ     $10     PULL DOWN REGISTER A
118          0011            PDRB            equ     $11     PULL DOWN REGISTER B
119          07F1            MOR             equ     $07F1
120          07F0            COPR            equ     $07F0
121
122
```

Flag Registers and System Equates: The following listing shows the definition of the RAM area in the microcontroller as well as locations of flags, registers and equates. Note that there are two bytes reserved for flags when only one was necessary. Since this program was well within the memory boundaries of the microcontroller, it was not necessary to eliminate this unneeded byte.

```
123                         ************************************************************
124                           *Ram flags and registers
125                         ************************************************************
126
127
128   00C0                                  org     RamArea
129                         ************************************************************
130   00C0                    R00             rmb     1
131                           ***************************
132 0000    PLAYING equ     $00     Indicates we are Playing back
133 0001    RECDING equ     $01     Indicates we are Recording
134 0002    MAKEIT0 equ     $02     Make it zero flag
135 0003    OPERATE equ     $03
136                           ****** equ$04
137                           ****** equ$05
138                           ****** equ$06
139                           ****** equ$07
140                           ***************************
141   00C1                    R01             rmb     1
142                           ***************************
143                           ******          equ     $10
144                           ******          equ     $11
145                           ******          equ     $12
146                           ******          equ     $13
147                           ******          equ     $14
148                           ******          equ     $15
149                           ******          equ     $16
150                           ******          equ     $17
151                           ***************************
152
153                           ***************************
154                           *NOW SET UP THE REGISTERS USED IN THE PROGRAM
155                           ******************************************
156   00C2STRTREGS
157   00C2ADDRLrmb 1        Address reg LOW
158   00C3ADDRHrmb 1        Address reg HIGH
159   00C4RECADDLrmb1       holds addr of last record (LOW)
160   00C5RECADDHrmb1       holds addr of last record (HIGH)
161   00C6SPIONErmb1        SPI Low byte - with control bits
162   00C7SPITWOrmb1        SPI High byte - address
```

```
163   00C8SEQCNTrmb1      Real Time Interrupt counter
164   00C9TOFCNTrmb1      Timer Overflow Flag counter
165   00CATEMPrmb  1      USED FOR VARIOUS STUFF
166   00CBTEMP1rmb 1      USED IN DELAY TIMERS
167   00CCTEMP2rmb 1      USED only in 16.879 mSEC TIMER
168   00CDTEMPOUTrmb1     Store of acc during SPI activity
169   00CETEMPINrmb1      Store of acc during SPI activity
170                        *
171   00CFENDREG
172                        *
173            *NOTE THAT THIS POINT CANNOT GO PAST $ WITHOUT LOOKING AT THE STACK USAGE
174                        ************************************************************
175                          *Define equates and other things
176                        ************************************************************
177           0004           DDR             equ     4
178           0020           POWRERUP        equ     $20
179           00A0           SETREC          equ     $A0
180           0000           STOPPWRDN       equ     $10(IAB also set)
181           0030           STOP            equ     $30     (IAB also set)
182           00E0           SETPLAY         equ     $E0
183           00B0           REC             equ     $B0
184           00E8           SETMC           equ     $E8
185           00F8           MC              equ     $F8
186           00F0           PLAY            equ     $F0
187           0030           RINT            equ     $30     (IAB also set)
188           0070           READADR         equ     $70     (no RUN, IAB set)
189
190
191                          *
```

Interrupt Routines: The interrupt routines are defined below. Note that the timer interrupt service routine (TIMESVC) and the software interrupt service routine (SWISVC) are not needed in this software. An accidental interrupt to those routines results in an immediate return from interrupt instruction (rti).

The external interrupt routine shuts off the ISD2500 device on the board that is used as a microphone preamp and speaker driver. It also sends a STOP opcode to the ISD33000 that is probably not needed because an interrupt from the ISD33000 always results from the end of an operation. The external interrupt routine then checks to see that the interrupt has been cleared, i.e., that the INT pin of the ISD33000 is back HIGH. If it is not, then an early chip revision of the ISD33000 is in the system and the device is in the overflow interrupt state. To insure compatibility with this early revision device, the routine then sends a SETPLAY opcode with an address of zero and then a STOP opcode to clear the address counter in the ISD33000 and clear the overflow interrupt.

```
192                        ************************************************************
193 *Interrupt servce routines and subroutine
194                        ************************************************************
195   00CF.CODE
196   00CF.RELATIVE
197   0300org     RomArea
198                          *
199                          *
200   0300                   TIMESVC
201                          *
```

```
202                          *NOTE:  Fop=.5587302 uSec (for a color burst xtal)
203                          *
204                          *
205
206   0300
207   0300   80                  rti
208   0301
209   0301swisvc
210   0301   80                  rti
211                          *
212
213 *-------------------------------------------------------
214 * START OF EXTERNAL INTERRUPT SERVICE ROUTINE
215 *-------------------------------------------------------
216 *
217
218 *The external int comes from the ISD33000. We first execute a
219 *STOP command to try to clear the interrupt.
220   0302extsvc
221   0302   10 01bsetPD,portbpower down ISD2500 audio chip
222
223   0304   1D 00bclrLOWBAT,portaturn off the LED
224   0306   17 C0bclrOPERATE,R00clear the OPERATE flag
225
226   0308   A6 30lda#STOP
227   030A   CD 04 5EjsrSPI_8stop the operation
228
229   030D   CD 04 C7jsrTPBNdelay
230
231 *We should have a cleared int by now.  If it's not cleared,
232 *we must be in Overflow.
233
234   0310   2F 11bihENDINTBranch if interrupt line is HIGH
235
236 *We in Overflow. Start play at zero then immediately stop it.
237 *This should clear the interrupt in a beta ISD33000 device
238
239   0312   3F C2clrADDRL
240   0314   3F C3clrADDRH
241   0316
242   0316   A6 E0lda#SETPLAYset up to play message with addr
243   0318   CD 04 2EjsrADDADDRadd the address to it
244   031B
245   031B   CD 04 6BjsrSPI_16start the playback
246
247 *Now do the STOP
248   031E   A6 30lda#STOP
249   0320   CD 04 5EjsrSPI_8stop the operation
250
251   0323ENDINT
252   0323   80rti
253   0324
254
255 *
```

```
256 *-------------------------------------------------------257* END OF EXTERNAL
INTERRUPT SERVICE ROUTINE
258 *-------------------------------------------------------259*
260 ;
261
```

Initialization: The reset initialization routine begins at address 324 (all address references are in hexadecimal). Note that the Mask Option Register (MOR) programming is shown for completeness but is "dummied out" so that this otherwise useless code is not executed. The mask option register must be programmed by the EEPROM programmer and must be set up manually in most programmers. Note also that the STOP command in line #321 is dummied out; the sleep instruction of the microcontroller is not used in this program.

```
262 ;***************************************************************************
263    ;       INITIALIZE REGISTERS
264   ;       POWER UP AND PRESET ROUTINE
265 ;***************************************************************************
266
267   0324reset
268 *
269   0324   A6 40USERlda#portaDDRset up to read push buttons
270   0326   B7 04staporta+DDR
271   0328   A6 1Flda#portbDDR
272   032A   B7 05staportb+DDR
273
274 *       lda     #$20
275 *       sta     MOR     enable Port A IRQs, no COP, enable
276 *       pull down resistors, enable OSC res.
277
278
279   032C   A6 00lda#$00Turn the LED off
280   032E   B7 00staporta
281
282   0330   A6 07lda#$07SI=LOW+SO=LOW+SK=LOW+SSBAR=HIGH+
283 *       PLAYREC=HIGH + PD=HIGH
284   0332   B7 01staport b
285
286   0334   A6 FClda#$FC
287   0336   B7 10staPDRAenable pull-down res PA0 & PA1
288   0338   A6 3Flda#$3F
289   033A   B7 11staPDRBenable no pull downs on port B
290   033C   3F C0clrR00
291   033E   3F C2clrADDRL
292   0340   3F C3clrADDRH
293   0342   3F C4clrRECADDL
294   0344   3F C5clrRECADDH
295   0346   3F CAclrTEMP
296
297   0348   5Fclrx
298
299   0349   A6 0Clda#$0CClear and disable timer int.
300   034B   B7 08staTSCR
301
```

```
302
303                  ;************ INITIALIZE ISD3300 *****************************
304   034D
305   034D   A6 20lda#POWRERUP
306   034F   CD 04 5EjsrSPI_8power up the ISD33000
307
308   0352   A6 20lda#POWRERUP
309   0354   CD 04 2EjsrADDADDRadd pwr up info to the addr info
310   0357
311   0357   CD 04 6BjsrSPI_16send in an address of all zeros
312
313   035A   CD 04 A1jsrFLASH1blink the led once
314
315   035D   9Crspreset the stack pointer
316   035E   9Aclienable interrups and GO!
317   035F
318
319   035FSTOPPIT
320
321 *       stop
322
323
```

Main Loop: The main loop simply looks for push-button closures on six switches. When a switch is closed, the routine branches to the proper point down in the code to execute the indicated operation. The microcontroller spends most of its time in this loop waiting for a switch closure.

```
324 ************************************************************************
325    *               TOP OF THE LOOP.  EVERYTHING STARTS FROM HERE           *
326    *                                                                       *
327 ************************************************************************
328    ********************  WAIT FOR AN INPUT HERE ******************************
329    *
330    *              MAIN LOOP WAITING FOR A SWITCH CLOSURE
331    ********************************************************************************
332 * Read the pushbuttons and branch if they are "alive".
333   035READ
334   035F   00 00 11brsetL2,porta,GOTOBEG
335   0362   02 00 1EbrsetL5,porta,SKIP2NXT
336   0365   04 00 3EbrsetL6,porta,PLAYNXT
337   0368   06 00 60brsetL1,porta,RECIT
338   036B   08 00 0FbrsetL4,porta,STOPITX
339   036E   0E 00 0FbrsetL7,porta,PLAYLASX
340
341   0371   20 ECbraREAD
342
343
```

GOTOBEG: The "Go To Beginning" routine only sets the flag bit MAKIT0 (for Make It Zero) located in the R00 flag register. The MAKIT0 bit will be used to indicate to other routines that record or playback should start from address zero of the ISD33000 when next executed. After setting the flag bit, this routine branches to the READX routine which runs a debounce timer. The READX routine is executed after any push-button

sequence to effectively debounce the push buttons.

Also, in each of the next three routines, SKIP2NXT (Skip to the Next message), PLAYNXT (Play the Next message) and RECIT (Record a message) look at the MAKIT0 bit to see if the address counter should be first be cleared to all zeros before executing the operation. Thus the RECIT routine will be told to begin at zero if the GOTOBEG push button was pressed before the RECIT routine is called. If the push button was not pressed, RECIT will record starting at the end of the last record or play operation without resetting the address counter.

```
344   ****************************** GO TO Beginning ***************************
345
346 *The Go To Beginning Button is pushed
347   0373GOTOBEG
348   0373   06 C0 53brsetOPERATE,R00,READZ
349   0376   14 C0bsetMAKEIT0,R00
350
351
352   0378   CD 04 ACjsrFLASH2blink the led twice
353
354   037B   20 4CbraREADZ
355   ******************************************************************************
356
```

Misc: A couple of the branches are too long. An intermediate jump is needed.

```
357   037DSTOPITX
358   037D   CC 03 F9jmpSTOPIT
359
360   0380PLAYLASX
361   0380   CC 04 05jmpPLAYLAST
362
```

SKIP2NXT: This routine sends a SETMC[1] opcode to the ISD33000 with an address of zero if the MAKIT0 bit is set or sends a MC opcode if it is not set. This routine does not start a record or play operation, but merely causes the address counter in the ISD33000 to be modified so that it is left pointed at the "next" message in the device.

```
363 ****************************** Message Cueing ****************************
364
365           *Now do a message cueing cycle . . . but first, do we do it from zero?
366   0383SKIP2NXT
367   0383   06 C0 43brsetOPERATE,R00,READZ
368
369   0386   05 C0 13brclrMAKEIT0,R00,NOCUE0if this flag clear,
370 *       no cue from zero
371
372 *We do a message cueing cycle from address zero
373   0389   15 C0bclrMAKEIT0,R00
```

1. See the "Opcode Summary" in the ISD 33000 Data Sheet for an explanation of the instructive opcodes.

```
374   038B
375   038B   3F C2clrADDRL
376   038D   3F C3clrADDRH
377   038F
378   038F   CD 04 A1 jsrFLASH1blink the LED once
379
380   0392   A6 E8lda#SETMCset up to do a msg cue + addr
381   0394   CD 04 2EjsrADDADDRadd the address to it
382   0397
383
384   0397   CD 04 6BjsrSPI_16do msg cue (but don't play)
385
386
387   039A   20 2DbraREADZdebounce and leave
388
389 *we do a message cueing cycle from the last address
390   039CNOCUE0
391   039C   CD 04 A1jsrFLASH1blink the LED once
392
393   039F   A6 F8lda#MC
394   03A1   CD 04 5EjsrSPI_8do msg cue (but don't play)
395
396   03A4   20 23braREADZdebounce and leave
397
398 ********************************************************************************
399   03A6
400
401
```

PLAYNXT: This routine sends a SETPLAY opcode to the ISD33000 with an address of zero if the MAKIT0 bit is set. This causes playback to start at address zero. If the MAKIT0 flag bit is not set, a playback operation begins at whatever address is currently in the ISD33000's internal address pointer. While playback is occurring, only the STOP push button will be recognized by the software.

```
402 ***************************** Play Next Message ****************************
403
404 *Play the next message . . . unless Go to Beginning has been pressed
405   03A6PLAYNXT
406   03A6   06 C0 79brsetOPERATE,R00,READXcheck if we already oper.
407   03A9   16 C0bsetOPERATE,R00
408
409   03AB   12 01bsetPLAREC,portbPut the ISD2500 into Play
410   03AD   11 01bclrPD,portbPower up the ISD2500
411
412   03AF   05 C0 10brclrMAKEIT0,R00,NOPLA0if flag clear, no play fm zero
413
414                          *We play a message from address zero
415
416   03B2   15 C0bclrMAKEIT0,R00clear the makit it zero flag
417   03B4   3F C2clrADDRL
418   03B6   3F C3clrADDRH
419   03B8
420   03B8   A6 E0lda#SETPLAYset up to play a msg with addr
```

```
421   03BA   CD 04 2EjsrADDADDRadd the address to it
422   03BD
423   03BD   CD 04 6BjsrSPI_16start the playback
424
425   03C0   1C 00bsetLOWBAT,portaturn on the LED
426
427   *Now fall through from starting at zero and send 8 more bits to continue play
428
429 *we really play the "next message"
430   03C2 NOPLA0
431   03C2   A6 F0lda#PLAYload for play with IAB bit set
432   03C4   CD 04 5EjsrSPI_8start the playback
433
434   03C7   1C 00bsetLOWBAT,portaturn on the LED
435
436   03C9   20 57READZbraREADXdebounce and leave
437
438 ************************************************************************
439   03CB
440
441
```

RECIT: This routine sends a SETREC opcode to the ISD33000 with an address of zero if the MAKIT0 bit is set. This causes record to start at address zero. If the MAKIT0 flag bit is not set, a record operation begins at whatever address is currently in the ISD33000's internal address pointer. While record is occurring, only the STOP push button will be recognized by the software.

An additional function is performed during the RECIT routine and before recording begins. If the MAKIT0 bit is not set, i.e., the internal address is to be used for record, then this address is read out of the ISD33000 using the SPIIN subroutine (which will be explained later). This address is stored in a set of registers[1] so that the PLAYLAST routine can make use of it. If the MAKIT0 bit is set, then a zero is stored in these registers.

```
442 *************************** Record Next Message ***************************
443
444               *Record the next message . . . unless Go to Beginning has been pressed
445   03CBRECIT
446
447   03CB   06 C0 54brsetOPERATE,R00,READXcheck to see if already oper
448   03CE   16 C0bsetOPERATE,R00
449
450   03D0   13 01bclrPLAREC,portbPut the ISD2500 into Record
451   03D2   11 01bclrPD,portbPower up the ISD2500
452
453   03D4   05 C0 16brclrMAKEIT0,R00,NOREC0if flag clear, no rec from 0
454
455
456 *We record message from address zero
457   03D7   15 C0bclrMAKEIT0,R00clear the makit it zero flag
458   03D9   3F C2clrADDRL
459   03DB   3F C3clrADDRH
460
```

1. *Since the ISD33000 family uses an address longer than 8 bits, it takes two 8-bit registers to share the address. In the software, these registers are called RECADDL and RECADDH.*

```
461 *Also clear the "record next" address bytes
462
463
464   03DD   3F C4clrRECADDL
465   03DF   3F C5clrRECADDH
466   03E1
467   03E1   A6 A0lda#SETRECset up to record a message with addr
468   03E3   CD 04 2EjsrADDADDRadd the address to it
469   03E6
470   03E6   CD 04 6BjsrSPI_16start the recording
471
472   03E9   1C 00bsetLOWBAT,portaturn on the LED
473   03EB
474   03EB   20 04braNOREC1
475
476 *Now send 8 more bits to continue record
477
478 *we really Record the "next message"
479   03EDNOREC0
480   03ED   A6 70lda#READADR
481   03EF   AD 4CbsrSPIINgo read the current addr before rec
482
483
484   03F1NOREC1
485   03F1   A6 B0lda#REC
486   03F3   AD 69bsrSPI_8start the recording
487
488   03F5   1C 00bsetLOWBAT,portaturn on the LED
489
490   03F7   20 29braREADXdebounce and leave
491
492 ********************************************************************************
493   03F9
494
495
```

STOPIT: This routine sends a STOP opcode to the ISD33000. This interrupts any operation in progress. If a record operation is interrupted, an EOM flag bit is stored in the device to mark the end of the message.

```
496 ************************ Stop Recording or Playing ************************
497
498 *Stop whatever we are doing . . . but don't corrupt the address register
499   03F9 STOPIT
500   03F9   A6 30lda#STOP
501   03FB   AD 61bsrSPI_8stop the operation
502
503   03FD   1D 00bclrLOWBAT,portaturn off the LED
504
505   03FF   17 C0bclrOPERATE,R00turn off the "Operate" flag
506
507   0401   10 01bsetPD,portbPower down the ISD2500
508
509   0403   20 1DbraREADX
510
```

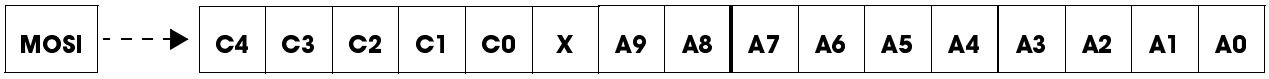
```
511 ********************************************************************************
512   0405
513
```

PLAYLAST: This routine retrieves the bytes that hold the address stored at the beginning of the last RECIT operation. It then sends a SETPLAY opcode and the address to the ISD33000 so that playback now begins at the address where the "last" recording started from.

```
514
515 ***************************** Play Next Message ****************************
516
517  *Play the last message we recorded
518   0405 PLAYLAST
519   0405   06 C0 1A brsetOPERATE,R00,READXcheck if we already oper
520   0408   16 C0 bsetOPERATE,R00
521
522   040A   12 01bsetPLAREC,portbPut the ISD2500 into Playback
523   040C   11 01bclrPD,portbPower up the ISD2500
524
525
526 *Go get the address we stored off just before we recorded (It's in
527 *RECADDH + RECADDL).  Put it in the address registers and GO!
528
529   040E   B6 C4ldaRECADDL
530   0410   B7 C2staADDRL
531
532   0412   B6 C5ldaRECADDH
533   0414   B7 C3staADDRH
534
535   0416   A6 E0lda#SETPLAYset up to play a message with addr
536   0418   CD 04 2EjsrADDADDRadd the address to it
537   041B
538   041B   CD 04 6BjsrSPI_16start the playback
539
540   041E   1C 00bsetLOWBAT,portaturn on the LED
541
542   0420   20 A0braNOPLA0Send 2nd command to set IAB bit
543
544 ********************************************************************************
545   0422
546
547
548 *after doing any and all the stuff,you arrive here to debounce the switches
549   0422   B6 00READXldaporta
550   0424   A4 9Fand#$9Fonly look at the push buttons
551   0426   26 FAbneREADXloop until the button is released
552
553 *OK, the button has been released
554   0428   CD 04 C7jsrTPBNgo wait for awhile
555   042B   CC 03 5Fjmp READ
556
557
558
```

559

ADDADDR Subroutine: Whenever we do any of the "SET" operations, we have to add a 10 bit address to the 5 bit ISD33000 opcode. The address starts with A0 in the LSB of the 16 bit word, with the opcode in the left-most 5 bits of the word. Graphically this looks like:

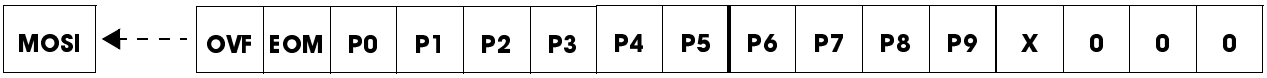


The two bytes to be shifted into the SPI port must be loaded such that the first bit shifted in is A0, the second is A1, etc. with the very last bit shifted into the SPI port being the C4 RUN bit. At that point the Slave Select pin will go HIGH to end the data input and start the operation as indicated by the bytes just shifted in.

In the ADDADDR subroutine, the accumulator brings in the opcode and the address is defined by the data in the ADDRL and ADDRH bytes. ADDRL contains A7–A0 and ADDRH holds A9 and A8 in the two LSB locations. This subroutine uses an AND and an OR operation to combine the opcode with bits A9 and A8 of the address and load SPIONE with this data. ADDRL is next written to SPITWO. SPIONE and SPITWO are the two byes that will be sent out of the SPI port of the micro.

```
560     ************************************************************
561     ************************************************************
562     *   SUBROUTINES START HERE!
563     ************************************************************
564     ************************************************************
565
566
567     ************************************************************
568     *SUBROUTINE ADDADDR
569     ************************************************************
570                       *This Subroutine adds the address to the control bits already
571                        *present in SPIONE. In doing so, it adds a second byte for
572                        *16 bit transfers into the ISD33000. This subroutine is
573                        *called with a control byte in the accumulator.
574
575   042EADDADDR
576   042E   B7 C6staSPIONEput the accumulator into SPI one
577
578   0430   B6 C3ldaADDRHget the upper byte of the address
579   0432   A4 03and#$03
580   0434   BA C6oraSPIONE
581   0436   B7 C6staSPIONE
582   0438
583   0438   B6 C2ldaADDRLGo get the lower byte
584   043A   B7 C7staSPITWO
585
586   043C   81rts
587
588
589
```

SPIIN Subroutine: This subroutine is used to read the address data out of the ISD33000 MISO pin before starting a record operation. This saves the "current address" so that a "play last record" operation is possible. Graphically the output side of the ISD33000 SPI port (MISO) looks like:



The OVF bit is presented to the MISO pin as soon as the Slave Select pin goes LOW. The first clock input to the ISD33000 SPI shifts the EOM to the MISO pin, and subsequent clocks shift the address data out, LSB first. Since we only read the MISO pin after the clock cycle, the OVF bit gets thrown away automatically. Note that the SHIFTIT routine (explained later) shifts the data into TEMPIN byte left to right. This causes the sense of the data to be inverted so that the EOM bit will be in the LSB position of the byte.

After the data is shifted out of the MISO pin, we are left with a byte holding P6–P0 plus the EOM bit and a second byte holding P9, P8 and P7. One more linked shift to the right of these two bytes dumps the EOM bit and positions the 10 bit address correctly for later use in the PLAYLAST routine.

It should be noted that whenever you read the ISD33000's SPI port data, you also are shifting data into the device. Accordingly, the calling routine must make sure the data written does not inadvertently start an unwanted operation, or interrupt an operation in progress. When SPIIN is called, the accumulator brings in the 5 bit opcode into the subroutine that is to be written to the MOSI port of the SPI. This routine assumes that an address will not be written into the SPI port at this time. Consequently the first byte written will be all zeros, followed by the second byte containing the opcode.

```
590                          ************************************************************
591 *SUBROUTNE SPIIN
592                          ************************************************************
593 * Read the SPI data from the chip, throw out the OVF and EOM
594 * bits, and store the address just retrieved in RECADDL and
595 * RECADDH. The accumulator comes in with the proper 5 bits
596 * of control so that nothing is disturbed.
597
598
599   043DSPIIN
600   043D   17 01bclrSK,portbMake sure the clock starts LOW
601   043F   15 01bclrSSBAR,portbDrop Slave Select
602
603   0441   B7 C6staSPIONESave the accumulator for later
604
605                           *we shift zeros in first
606
607   0443   3F CAclrTEMPput all zeros in temp
608   0445   AD 39bsrSHIFTIT
609
610   0447   B6 CEldaTEMPINget the data just shifted in
611   0449   B7 C4staRECADDL
612
613                           * note that EOM bit is still in RECADDL. We will
614                           * fix this later.
615
```

```
616   044B   B6 C6ldaSPIONEgo get the original accumulator
617   044D   B7 CAstaTEMP
618
619   044F   AD 2FbsrSHIFTITgo do the second byte
620
621
622 * TEMPIN now has upper 3 bits of the address in it. We will
623 * shift 1 of those bits into RECADDL. The last 2 bits remain
624 * in TEMPIN and this becomes RECADDH.
625
626   0451   34 CElsrTEMPIN
627   0453   36 C4rorRECADDL
628
629   0455   B6 CEldaTEMPIN
630   0457   B7 C5staRECADDH
631
632   0459   14 01bsetSSBAR,portbSlave Select goes HIGH to end
633                          *cycle
634   045B   19 01bclrSO,portbLeave this LOW when finished
635   045D   81rts
636
637
```

SPI_8 Subroutine: This subroutine is used to shift 8 bits into the MOSI pin of the ISD33000. The accumulator brings in the byte to be shifted. The SHIFTIT subroutine does the actual shifting of the data.

```
638                          ************************************************************
639 *SUBROUTNE SPI_8
640                          ************************************************************
641                           *SPI driver subroutine - outputs 8 bits. This routine sends
642 *the SPIONE byte out the bit banged SPI port.
643
644   045ESPI_8
645   045E   17 01bclr    SK,portb        Make sure the clock starts LOW
646   0460   15 01bclr    SSBAR,portb     Drop Slave Select
647
648   0462   B7 CAsta     TEMP
649   0464   AD 1Absr     SHIFTIT
650
651   0466   14 01bset    SSBAR,portb     Slave Select goes HIGH to end
652 *       cycle
653   0468   19 01bclr    SO,portb        Leave this LOW when finished
654   046A   81rts
655
656
```

SPI_16 Subroutine: This subroutine is used to shift 16 bits into the MOSI pin of the ISD33000. The SPITWO byte is shifted in first and the SPIONE bit is shifted in second. The SHIFTIT subroutine does the actual shifting of the data.

```
657                          ************************************************************
658                            *SUBROUTNE SPI_16
659                          ************************************************************
```

```
660                          *SPI driver subroutine - outputs 16 bits. This routine sends
661 *the SPIONE and SPITWO bytes out the bit banged SPI port.
662
663   046B SPI_16
664   046B   17 01bclr    SK,portb        Make sure the clock starts LOW
665   046D   15 01bclr    SSBAR,portb     Drop Slave Select
666
667   046F   B6 C7lda     SPITWO
668   0471   B7 CAsta     TEMP
669
670   0473   AD 0Bbsr     SHIFTIT
671
672   0475   B6 C6lda     SPIONE
673   0477   B7 CAsta     TEMP
674
675   0479   AD 05bsr     SHIFTIT
676   047B
677   047B   14 01bset    SSBAR,portb     Slave Select goes HIGH to end
678                           *cycle
679   047D   19 01bclr    SO,portb        Leave this LOW when finished
680   047F   81rts
681
682
683
```

SHIFTIT Subroutine: This subroutine does all the shifting of data into and out of the SPI port of the ISD33000. The TEMP register brings in the 8 bit data to be shifted out and the TEMPIN register brings data out of the routine. SHIFTIT talks directly to the ports of the microcontroller.

```
684 ************************************************************
685 *SUBROUTNE SHIFTIT
686 ************************************************************
687 *This subroutine shifts out 8 bits from the SPI Port
688
689   0480SHIFTIT
690   0480   A6 08lda#8
691   0482   B7 CBstaTEMP1put an 8 count into temp 1
692
693   0484   B6 CAldaTEMP
694
695   0486   44OUTAGNlsrashift the LSB into carry bit
696   0487   24 04bccOUTZERO
697
698   0489   18 01OUTONEbsetSO,portboutput a "1"
699   048B   20 02braCONTSPI
700
701   048D   19 01OUTZERObclrSO,portboutput a "0"
702
703
704 *Now toggle the clock to shift the data
705   048F   16 01CONTSPIbsetSK,portb
706   0491   17 01bclrSK,portb
707
708 *now look at incoming data
```

```
709
710   0493   0A 01 03brsetSI,portb,INONE
711   0496   98clcit's a 0, clear carry bit
712   0497   20 01braCONTIN
713
714   0499   99INONEsecit's a 1, set the carry bit
715
716   049A   36 CECONTINrorTEMPINbring the bit into the acc
717
718   049C   3A CBdecTEMP1
719   049E   26 E6bneOUTAGN
720   04A0
721   04A0   81rts
722
```

FLASH1 Subroutine: The FLASH1 subroutine blinks the LED once.

```
723                        ************************************************************
724                           *SUBROUTNE FLASH1
725                        ************************************************************
726                           *This subroutine flashes the LED once
727
728   04A1FLASH1
729   04A1   1C 00bsetLOWBAT,portaturn on the LED
730   04A3
731   04A3   A6 96lda#150
732   04A5   B7 CBstaTEMP1use 150 at the delay
733
734   04A7   AD 22bsrKEYDLYdelay
735   04A9   1D 00bclrLOWBAT,portaturn off the LED
736   04AB   81rts
737
738
739
```

FLASH2 Subroutine: The FLASH2 subroutine blinks the LED twice.

```
740                        ************************************************************
741                           *SUBROUTNE FLASH2
742                        ************************************************************
743                           *This subroutine flashes the LED twice
744   04AC                    FLASH2
745   04AC   1C 00bset    LOWBAT,porta    turn on the LED
746
747   04AE   A6 96lda     #150
748   04B0   B7 CBsta     TEMP1           use 150 at the delay
749
750   04B2   AD 17bsr     KEYDLY          delay
751   04B4   1D 00bclr    LOWBAT,porta    turn off the LED
752
753   04B6   A6 96lda     #150
754   04B8   B7 CBsta     TEMP1           use 150 at the delay
755
```

```
756   04BA   AD 0Fbsr     KEYDLY          delay
757   04BC   1C 00bset    LOWBAT,porta    turn on the LED
758
759   04BE   A6 96lda     #150
760   04C0   B7 CBsta     TEMP1           use 150 at the delay
761
762   04C2   AD 07bsrKEYDLYdelay
763   04C4   1D 00bclrLOWBAT,portaturn off the LED
764   04C6   81rts
765
766
767
```

TPBN Subroutine: This subroutine is used to generate delays in the program. Calling TPBN directly gives approximately a 1/4 second delay. KEYDLY can also be called as a subroutine. In this case, the accumulator brings in a variable that initiates a delay shorter than TPBN.

```
768 ************************************************************
769 *SUBROUTNE TPBN
770 ************************************************************
771 *USED FOR TIMING VARIOUS STUFF IN THE PROGRAM
772 *
773
774 *TPBN IS THE PUSH BUTTON DELAY IN PUSH BUTTON MODE
775   04C7A6 FA TPBNlda   #250    DELAY 250 MILLISECONDS (approx)
776   04C9   B7 CBstaTEMP1
777
778   04CB   B6 CBKEYDLYldaTEMP1(3)
779   04CD   27 0AbeqFINDLY(3)
780   04CF   3A CBdecTEMP1(5)
781
782
783
784                        ************************************************************
785                        *WAIT1    GENERATES A DELAY (1.154 mSEC)
786                        ************************************************************
787 *WAIT1 GENERATES A 1.154 MILLISECOND DELAY.  IT DOES NOT DISTURB THE
788 *ACCUMULATOR. FROM A BSR (CALLING THIS ROUTINE) THROUGH THE RTS (ENDING
789 *THIS ROUTINE, IT TAKES 2065 CYCLES x 4.3656 uSEC = 1.154 MSec. THIS THING
790                          *LOOPS 256 TIMES.
791
792   04D1   3F CC WAIT1clrTEMP2(5)
793   04D3   3C CC WAIT2incTEMP2(5)
794   04D5   26 FCbneWAIT2(3)
795
796   04D7   20 F2bra KEYDLY(3)
797
798   04D9   81FINDLYrts
799
800
801
802 *
803
```

```
804
805
806
807
808
809 * NOTE: THE LAST USABLE ADDRESS IS $7CF
810
811
812
813
814
815
```

Push Button Operation Notes

```
816       *Instructions:
817       *Six of the 9 push-buttons are labeled on the PCB. Pushing the Yellow
818       *"Go_to_Beg" button will reset the address pointer to the front of the
819       *chip or address 000. The indication that this has been done will be a
820       *double flash of the LED, D11, in the bottom left corner of the PCB.
821       *
822       *Pushing the Red "Record" button will turn on the Red LED to indicate
823       *that the chip is now recording anything it hears at the microphone M1
824       *near the top center of the board. The board will continue to Record
825       *until the end of the chip is reached or the Black "Stop" button is pressed.
826       *At that time the LED will go out and the board will stop Recording.
827       *
828       *Pushing the White "Play_Last" button will playback what you have just
829       *recorded. This message will play through to its end or stop when you
830       *press the Black "Stop" button
831       *
832       *Pushing the Yellow "Go_to_Beg" button, and then the White "Play_Next"
833       *button will play messages from the beginning of memory through to its
834       *end or stop/pause when you press the Black "Stop" button. To resume
835       *playback push play-next again if playback is paused. To play the next
836       *message press play next again.
837       *
838       *The Blue "Skip_to_Next" button will let you bypass a message and play
839       *the one after that message. For example, had you recorded three messages,
840       *beginning at the front of the chip, and gone back to the beginning after
841       *the last message then you could press the White "Play_Next" button to play
842       *message #1, press the Blue "Skip_to_Next" button to bypass message #2 and
843       *then Press the White "Play_Next" to play message #3.
844
845
846
846
```

Cross Reference Listing

```
Defined Symbol NameValueReferences
575 ADDADDR 042E     243 309 381 421 468 536
158 ADDRH   00C3     240 292 376 418 459 533 578
157 ADDRL   00C2     239 291 375 417 458 530 583
Pre CODE    00C0     195
716 CONTIN  049A     712
705 CONTSPI 048F     699
```

```
120 COPR    =  07F0
Pre DATA    0000
177 DDR     =  0004     270 272
251 ENDINT  0323     234
171 ENDREG  00CF
798 FINDLY  04D9     779
728 FLASH1  04A1     313 378 391
744 FLASH2  04AC     352
347 GOTOBEG 0373     334
714 INONE   0499     710
116 ISCR    =  000A
 97 IntVects=  07F8     103
778 KEYDLY  04CB     734 750 756 762 796
 57 L1      =  0003     337
 54 L2      =  0000     334
 58 L4      =  0004     338
 55 L5      =  0001     335
 56 L6      =  0002     336
 61 L7      =  0007     339
 60 LOWBAT  =       0006    223 425 434 472 488 503 540 729 735 745
    751 757 763
134 MAKEIT0 =  0002     349 369 373 412 416 453 457
185    MC=  00F8393
119    MOR=  07F1
804    MSGTABL04DA
390    NOCUE0 039C369
430    NOPLA0 03C2412 542
479    NOREC0 03ED453
484    NOREC1 03F1474
135    OPERATE =0003224 348 367 406 407 447 448 505 519 520
695    OUTAGN0486719
698    OUTONE 0489
701    OUTZERO048D696
Pre    PAGE00000
 69    PD=  0000221 410 451 507 523
117    PDRA=  0010287
118    PDRB=  0011289
 70    PLAREC=  0001409 450 522
186    PLAY=  00F0431
132    PLAYING=  0000
518    PLAYLAST0405361
360    PLAYLASX0380339
405    PLAYNXT03A6336
178    POWRERUP=  0020305 308
806    PTTABL04DA
130    R0000C0224 290 348 349 367 369 373 406 407 412
    416 447 448 453 457 505 519 520
141    R0100C1
 59    RAC=  0005
333    READ035F341 555
188    READADR=  0070480
549    READX0422406 436 447 490 509 519 551
436    READZ03C9348 354 367 387 396
183    REC =  00B0485
160    RECADDH00C5294 465 532 630
159    RECADDL00C4293 464 529 611 627
```

```
133    RECDING=  0001
445    RECIT03CB337
187    RINT=  0030
 94    RamArea =  00C0128
 96    RomArea=  0300197
163    SEQCNT00C8
184    SETMC=  00E8380
182    SETPLAY=  00E0242 420 535
179    SETREC                          =  00A0     467
689    SHIFTIT                            0480     608 619 649 670 675
 74    SI                              =  0005     710
 72    SK                              =  0003     600 645 664 705 706
366    SKIP2NXT                           0383     335
 73    SO                              =  0004     634 653 679 698 701
599    SPIIN                              043D     481
161    SPIONE                             00C6     576 580 581 603 616 672
162    SPITWO                             00C7     584 667
663    SPI_16                             046B     245 311 384 423 470 538
644    SPI_8                              045E     227 249 306 394 432 486 501
 71    SSBAR                           =  0002     601 632 646 651 665 677
181    STOP                            =  0030     226 248 500
499    STOPIT                             03F9     358
357    STOPITX                            037D     338
319    STOPPIT                            035F
180    STOPPWRDN                       =  0000
156    STRTREGS                           00C2
 95    StkTop                          =  00FF
115    TCR                             =  0009
165    TEMP                               00CA     295 607 617 648 668 673 693
166    TEMP1                              00CB     691 718 732 748 754 760 776 778 780
167    TEMP2                              00CC     792 793
169    TEMPIN                             00CE     610 626 629 716
168    TEMPOUT                            00CD
200    TIMESVC                            0300     104
164    TOFCNT                             00C9
775    TPBN                               04C7     229 554
114    TSCR                            =  0008     300
269    USER                               0324
792    WAIT1                              04D1
793    WAIT2                              04D3     794
220    extsvc                             0302     105
 51    porta=0000  223 270 280 334 335 336 337 338 339 425
    434 472 488 503 540 549 729 735 745 751
    757 763
 52    portaDDR                        =  0040     269
 66 portb   =      0001    221 272 284 409 410 450 451 507 522 523
    600 601 632 634 645 646 651 653 664 665
                                                  677 679 698 701 705 706 710
 67    portbDDR                        =  001F     271
267    reset                              0324     107
209    swisvc                             0301     106
Lines Assembled :  846            Assembly Errors :  0
```

APPENDIX

Figure 1 is used to adapt the COPS socket on the ISD-ES302 demo board to the Motorola MC68HC705J1A microcontroller. Plug J2 plugs into the COPS socket and the Motorola MC68HC705J1A plugs into the J1 socket. Also, R7 (4.7 Ω), which connects to the Interrupt output of the ISD33000, must be shunted with a 1N914 signal diode with the cathode toward the ISD chip. The Motorola microcontroller cannot see interrupts unless this is done.

Figure 1: Adapter Board Schematic