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AN495/D

RDS decoding for an HC11-controlled radio

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Introduction

This application note describes, and lists the software of, the RDS aspects of the HC11 radio controller described in AN494/D. The complete application constitutes a synthesised multiband radio which includes RDS decoding (FM, band II) and uses an MC68HC(7)11 microprocessor whose program can be on-chip or contained in an external EPROM. Both LCD and VFD 16-character dot-matrix display modules can be used to display RDS and tuning information. Traffic messages on the current frequency or on another frequency, initiated by the reception of RDS EON data, are handled. The station carrying the TA is tuned for the duration of the message, followed by a return to the original frequency.

Figure 1 shows a block diagram of the application. The microprocessor used is the MC68HC(7)11. The K4 (and similar chips such as the P2 and PH8) can be used in expanded mode but the application has been included in the ROM of an E32 (ZC403311) and two PH8s (ZC428200 and ZC428202). In order to use the ROMed parts in this application, the first three bytes of EEPROM should contain an extended jump to the appropriate state address. The E32 (ZC403311) requires $7E, $90 and $00 at addresses $B600, $B601 and $B602, while the PH8 requires $7E, $40 and $00 at addresses $0D00, $0D01 and $0D02. This can be done using either PCbug11 or the Buffalo monitor (see reference 5). The E32 version uses all the I/O and can therefore only be used in single-chip mode. The circuit diagram of the HC11E controller is shown in figure 2. The 40 programs (10 on FM and MW and 20 on SW) which can be stored using the HC11E's on-chip EEPROM contain, in addition to frequency, an 8-character name (PS name on a station with RDS) and, on FM only, PI code and a traffic announcement inhibit bit.

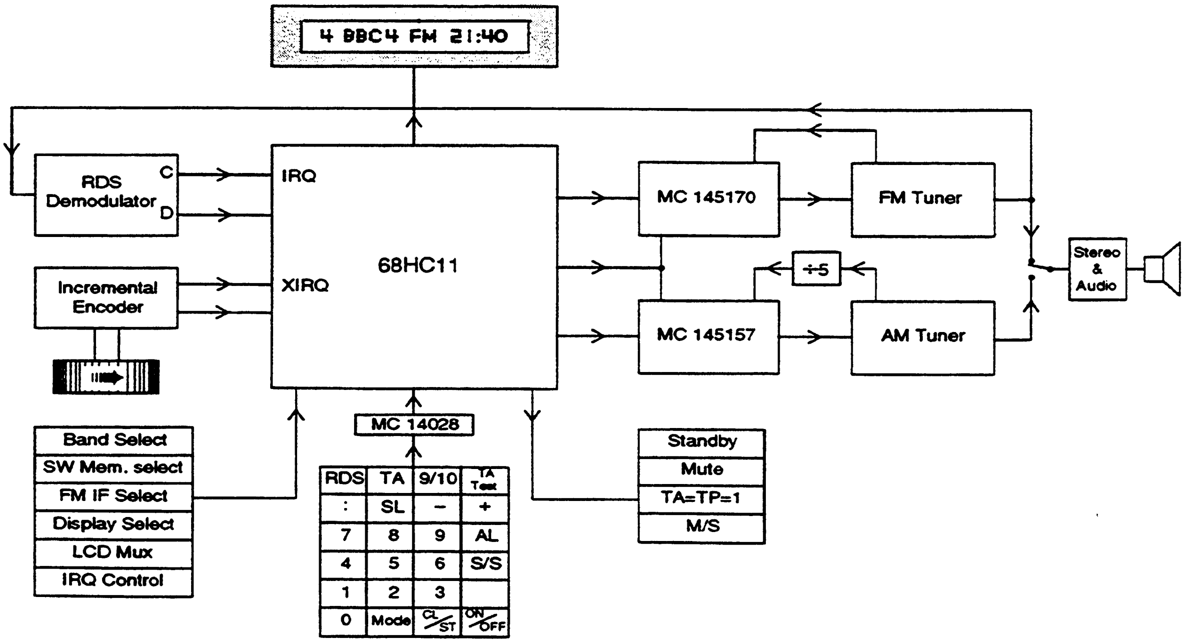

Figure 1. Main block diagram

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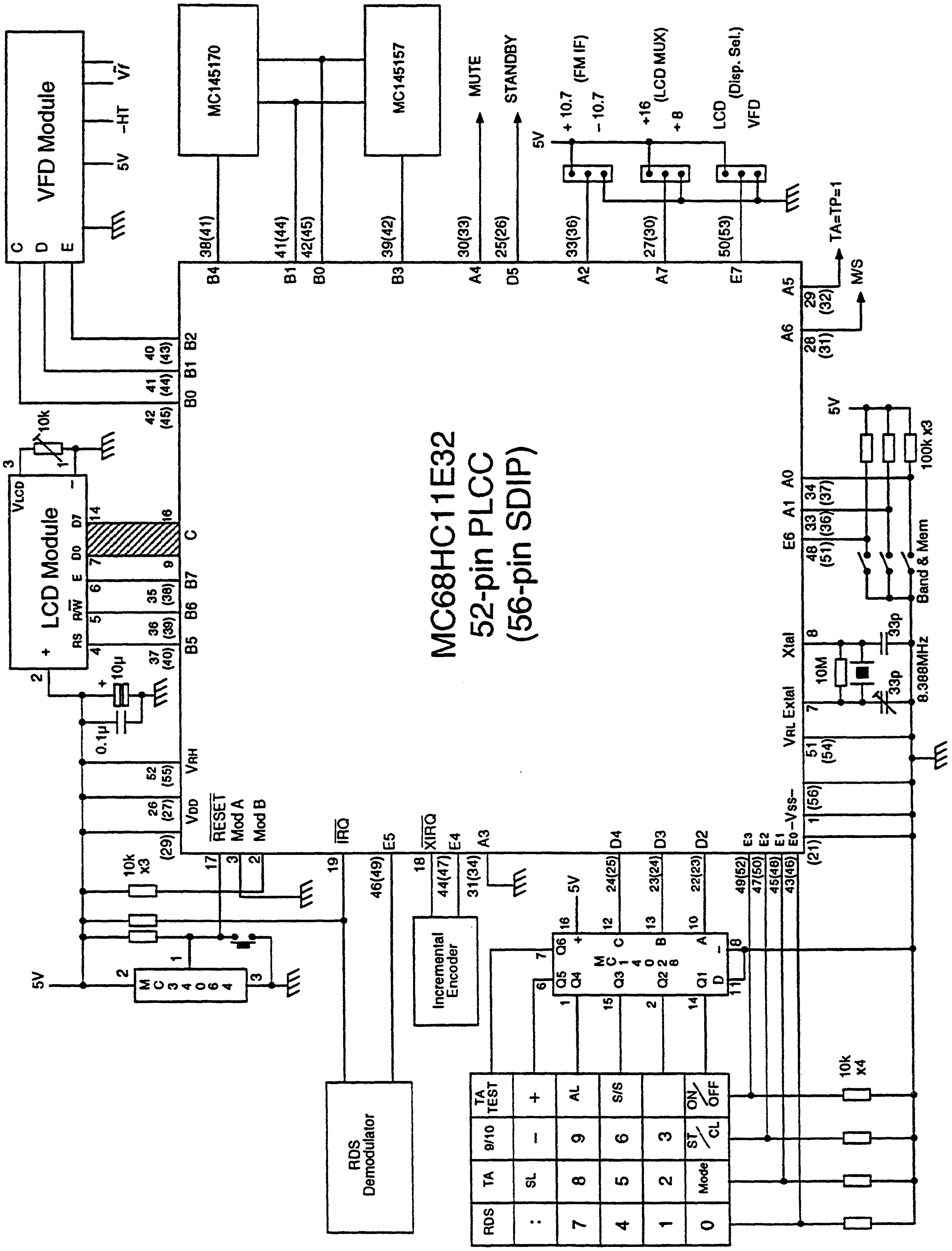

Figure 2 68HC11E32 circuit

RDS features

The Radio Data System adds a digital data capability to the FM VHF transmissions on band II (87.5 to 108 MHz). The specification is defined in CENELEC EN 50067 (formerly EBU Technical Document 3244, reference 2). An MC68HC05E0 implementation of RDS was described in AN460/D (reference 3). It monitored the RDS activity on the MPX signal of a VHF radio but was not able to tune the radio and could therefore not use AF or EON data. This application can tune the radio and uses EON data to retune the radio when a traffic announcement (TA) is taking place on another frequency. An announcement is initiated by an RDS group 14B and the radio retunes if TAs are enabled. At the end of the announcement the original station is re-tuned. TAs are not active in standby mode (standby line high).

To transmit the data, a subcarrier is added at 57 kHz. This subcarrier is amplitude modulated with the shaped bi-phase coded data signal. The subcarrier itself is suppressed to avoid data modulated cross-talk in phase-locked loop stereo decoders and to maintain compatibility with the German ARI system which uses the same subcarrier frequency. Information is sent in groups of four 26-bit blocks. Each group of 104 bits is one of several types containing different information. It is up to the broadcaster to decide which features are transmitted as long as the specified format is adhered to and PI, PTY and TP are included. Each group contains a different sub-set of the RDS features. A list of all currently defined features is shown in table 1.

Table 1. RDS features

Feature	Information
PI	Program identification
PTY	Program type
PS	Program service name
RT	Radiotext
CT	Clock time and date
AF	Alternative frequencies
TA	Traffic announcement
TP	Traffic program
MS	Music/speech switch
DI	Decoder identification
PIN	Programme item number
EON	Enhanced other networks
TDC	Transparent data channel
INH	In-house data

The retrieval of data is carried out by demodulation hardware which generates clock and data signals that can be used by the microprocessor. Suitable devices which can perform this function include SAA6579, SAA7579T (plus an external filter), TDA7330, LA2231 and RDS hybrids.

This application supports PI, PTY, PS, RT, CT, TP, TA, MS, DI, PIN and EON. These features facilitate permanent display of the 8-digit station name (PS) and time (CT) and, on request, can display program type (PTY), radiotext data (RT) and the status of the other RDS information (see table 6). EON data can be displayed and used to switch to traffic announcements, but the retuning features associated with AF are not supported as they are only appropriate for a radio intended for use in a vehicle. In a car radio, AF data would be used to tune the radio to the strongest signal carrying the selected service.

Table 2 shows all the currently defined RDS group types and the RDS features they contain. PI, PTY and TP are contained in all groups. This allows this information to be gathered quickly after the radio has been retuned. The other features are contained only in specific group types and the update frequency is thus largely up to the broadcaster. The next most important information for a car radio (AF and TA) is sent using type 0 groups which also contain the M/S and DI bits which can be used to control hardware within the radio. There are two methods of increasing the repetition rate of important information. Type B groups contain the PI code twice (in blocks 1 and 3) and type 15B groups also repeat their block 2 information (TP, PTY, M/S and DI) in block 4. Information which is required less frequently (e.g., PIN) is sent less often, while type 4 groups (CT) are sent only once per minute.

Table 2. RDS Groups

Group	Features
All	PI, PTY, TP
0	TA, DI, MS, PS, AF
1	PIN
2	RT
3	ON (replaced by EON)
4A	CT
5	TDC
6	INH
14	EON
15B	TA, DI, MS

Other network (ON) information was originally sent using type 3 groups. Limitations in the definition of this group has caused it to be superseded by type 14 groups. This enhanced other network (EON) group type effectively replaces type 3 groups which are no longer used. This application uses type 14 groups but does not handle the old type 3 groups.

Decoding

Each 26-bit block contains 16 bits of data and 10 extra bits which are used for synchronisation and error detection. There are no gaps between blocks or groups, the synchronisation being done by looking for specific checkwords in the incoming data. In order to look for a checkword a stream of 26 consecutive data bits has to be multiplied by a fixed 10x26 matrix (Figure 3).

The result of this multiplication is a 10-bit word which is compared with allowed values. There are 5 of these 10-bit "syndromes", one for each of blocks 1, 2 and 4 and two for block 3 (see table 3). The alternative syndrome for block 3 is used in the B version of a group. In this version the PI code is sent in block 3, replacing what would be sent in the A version of the same group type. This is done to increase the frequency of sending the PI code so that it can be acquired more quickly.

```
10 0000 0000     ($02,$00)
01 0000 0000     ($01,$00)
00 1000 0000     ($00,$80)
00 0100 0000     ($00,$40)
00 0010 0000     ($00,$20)
00 0001 0000     ($00,$10)
00 0000 1000     ($00,$08)
00 0000 0100     ($00,$04)
00 0000 0010     ($00,$02)
00 0000 0001     ($00,$01)
10 1101 1100     ($02,$DC)
01 0110 1110     ($01,$6E)
00 1011 0111     ($00,$B7)
10 1000 0111     ($02,$87)
11 1001 1111     ($03,$9F)
11 0001 0011     ($03,$13)
11 0101 0101     ($03,$55)
11 0111 0110     ($03,$76)
01 1011 1011     ($01,$BB)
10 0000 0001     ($02,$01)
11 1101 1100     ($03,$DC)
01 1110 1110     ($01,$EE)
00 1111 0111     ($00,$F7)
10 1010 0111     ($02,$A7)
11 1000 1111     ($03,$8F)
11 0001 1011     ($03,$1B)
```

Figure 3 10x26 decoding matrix

Table 3. Syndromes

Block	Syndrome	Binary	Hex.
1	A	11 1101 1000	$03,$D8
2 ·	B	11 1101 0100	$03,$D4
3	C	10 0101 1100	$02,$5C
	C'	11 1100 1100	$03,$CC
4	D	01 0101 1000	$01,$58

This syndrome test has to take place after each bit is received, using the last 26 bits, until a valid syndrome is found. In this application, only syndrome A is accepted during the bit-by-bit syndrome check and the data is used only after four valid syndromes have been acquired. A more complex algorithm could allow any syndrome to be accepted during initial synchronisation and require less than four valid syndromes before the data is used. This would reduce the time taken to acquire the PI code, which is also included in block 3 of type B groups, but increases the likelihood that random data, giving a valid syndrome, will be used in error. The bit rate is 1187.5 Hz so the control microprocessor is busy during this initial synchronisation (about 20% of the capability of an HC11 at a 2 MHz bus frequency). Once a valid syndrome has been found, subsequent syndrome checks need be done only after the next 26 bits have been received, as this is when the next valid syndrome would be expected. If it is not found, then bit-by-bit checking is re-started. Once consecutive A, B, C (or C') and D syndromes have been detected, a complete group has been acquired and the data can be used.

Software

The software for this application is in three modules and was assembled and linked using the Introl relocatable assembler and linker. The first module is listed in AN494/D and contains all the main control routines including the main loop and keyboard scanning and the function to be performed by each key. The second and third modules are listed in this application note. The second module (Appendix 1) contains the RDS and display functions while the third module (Appendix 2) is the 4-function 9-digit integer BCD arithmetic required for the MJD date calculations. EB419/D (reference 5) describes and lists additional debug code contained in the ROMed parts.

The second module services the RDS and timer interrupts and performs all RDS and display functions. The RDS functions were converted from the HC05 application described in AN460/D (reference 3) using the methods described in AN478/D (reference 4).

The RTI timer interrupt routine (TINTB) updates the RT scrolling pointers (DISP1 and DISP2). These pointers are incremented regularly whether or not an RT display is active so that the software can be easily converted to using a 2-line LCD module in which the top line is the normal display of PS-name, time etc., and the lower line is a permanent display of scrolling RT. The timer interrupt also decrements the sleep timer and updates the RAM locations used to store hours, minutes and seconds. All RDS data (except date and time) is cleared by this routine if no valid RDS data is detected for a period of 10 seconds. The RTI timer is enabled to cause an interrupt every 31.25 ms to run the real-time clock. Correct operation of this clock in the absence of an RDS signal requires that a 8.388 MHz crystal be used.

Hardware interrupts are vectored to jump to SDATA where serial data is received from the RDS demodulator. The clock edge causes an interrupt and a data bit is read by bit 5 on port E. The bit is shifted into a 4-byte RAM register and, if appropriate, the matrix multiplication is performed. The state of the flag at bit 0 of STAT2 determines if the multiplication is to take place after every bit or only after 26 bits have arrived. The multiplication is performed using two EOR instructions for every bit (two are required as the 10-bit syndrome requires two bytes). As the top of the matrix (see figure 3) is the unity matrix, the first 10 bits are transferred directly into the accumulators. This reduces what is a rather long and repetitive piece of code. It could be shortened by using a loop but this would incur an unacceptable penalty in execution time.

After the multiplication has been performed, the resultant 10-bit number is compared with the allowed syndromes (see table 3). The variable LEV records the current block level. It is initially zero but is incremented each time a valid syndrome is found. When it is zero, only syndrome A is accepted. If this is found then syndrome B is expected 26 bits later so when LEV is one, only syndrome B is accepted. If an invalid syndrome is found, LEV is cleared, the syndrome confidence level CONF is decremented and the interrupt is ended.

When a valid syndrome is found, CONF is increased by 4 and the 16 data bits saved in the relevant bytes of TMPGRP. If the valid syndrome is type D then a complete group has been received and all 8 bytes are transferred to the 8 RAM locations at GROUP. This double buffering means that the data in GROUP can be used while interrupts are overwriting TMPGRP with new data. Complete groups of data are handled in the subsequent routines according to their group type.

The confidence level CONF is used to decide what should be done if the data becomes unreliable due to a poor RF input to the receiver. When the first valid syndrome is found it is initialised to 42. Subsequent valid syndromes increment it by four and invalid ones decrement it by 1. If CONF falls below 41, then it is assumed that synchronisation has been lost and a bit-by-bit re-synchronisation is carried out. If it falls below 10, the signal is deemed unacceptable and the displays are re-initialised. The confidence level is not incremented by the detection of a valid syndrome if it is higher than 56.

The listed modules contain the display routines described in AN494/D. The displays are only updated when there is a change in the displayed data. At 8 Hz a check is made to see if any characters have changed, and if there has been a change, the display update routine is executed. This is done to minimise interference caused by communication with the displays. The colon between the hours and minutes of the time display changes at 1 Hz. This can be disabled (colon permanently displayed) by using the Time Colon key. The display routine (MOD) is executed in the idle loop if the flag bit 3 of STAT2 is set. It is set every 125 ms by timer B interrupts. If flag bit 4 of STAT2 is set the display is initialised indicating no valid RDS data. The dot-matrix modules are then updated, if necessary, with new data. Before each occasion that something is written to the LCD module, the subroutine WAIT is used. This checks that the controller in the module is not busy. The different display formats are selected by checking the various flags and the relevant routine executed. The normal display permanently shows PS name and time. As the locations in RAM used for hours and minutes contain binary numbers, they are converted to BCD before being written to the relevant bytes in DISP. Once all 16 bytes in DISP have been loaded, loops are used to send the data to the display modules. The standby display (alarm not enabled) shows date and time. After a power-up the display "Mon 0 inv 0:00" indicates that the date and time are invalid. The date and time will be correct once a valid RDS CT group has been received.

The VFD routine sends the same data as is shown on the LCD module to the serial VFD module. The display driver used has a different character set from the standard ASCII set used by the LCD module. The table VTAB is used to convert ASCII data into the required character in the VFD module. The small table INITF is used to send the required initialisation bytes to the VFD module. This module does not require a busy check but does require a delay between successive bytes. This is satisfied by the wait loop within the serial output loop VFDL.

Table 4. RDS Block and Group structure

Group	Block 1	Block 2	Block 3	Block 4
0,15B	PI code	15-12: Group no. 11: Group type 10: TP flag 9-5: PTY code 4: TA flag 3: M/S bit 2: DI bit 1-0: PS/DI address	AF (PI code in type 0B and 15B)	PS name 2 ASCII characters (as block 2 for 15B)
1	PI code	15-12: 0001 11: Group type 10: TP flag 9-5: PTY code 4-0: not used	not used (PI code in type 1B)	PIN data 15-11: day-of-month 10-6: hour 5-0: minute
2A	PI code	15-12: 0010 11: 0 10: TP flag 9-5: PTY code 4: Text A/B flag 3-0: Text address	RT 2 ASCII characters	RT 2 ASCII characters
4A	PI code	15-12: 0100 11: 0 10: TP flag 9-5: PTY code 4-2: not used 1-0: MJD (16-15)	CT 15-1: MJD (14-0) 0: hour (4)	CT 15-12: hour (3-0) 11-6: minute (5-0) 5: offset sense 4-0: offset (4-0)
14A	PI code	15-12: 1110 11: 0 10: TP flag 9-5: PTY code 4: TP (ON) flag 3-0: usage code	EON code: 0-3: PS 4: AF 5-9: AF (map) 10-11: not used 12-15: not imp.	PI (ON)
14B	PI code	15-12: 1110 11: 1 10: TP flag 9-5: PTY code 4: TP (ON) flag 3: TA (ON) flag 2-0: not used	PI code	PI (ON)

Table 4 shows the bit structure of the groups which are used in this application. Block 1 always contains the PI code. The five most significant bits in block 2 determine the group number and type. Block 2 also contains TP and PTY data. The uses of the other bits in blocks 2, 3 and 4 depend on the group number and type. Type B groups repeat the PI code in block 3 but type A groups contain a variety of information in blocks 3 and 4 depending on the group number.

PI, PTY, and TP

If a complete group has been received, the data can be processed. The buffering used would allow this to be done outside the interrupt but in this case there is sufficient time to do it within the interrupt. As they are contained in all groups, PI, PTY and TP are handled first. PI is a 2-byte number which identifies the country, coverage area and service. It can be used by the control microprocessor but is not normally intended for display. This application facilitates the display of the current PI code. A change in PI code causes the initialisation of all RDS data as it indicates that the radio has been retuned. When a program is stored in NVM, its PI code is saved with the frequency and PS name. This information is used to find the correct frequency to tune to when a traffic announcement is initiated by EON. The EON information (contained in a group 14B) includes the PI code of the station transmitting the message. Further use would be made of the PI code in an application which used AF information.

PTY is a 5-bit number which indicates the current program type. At present 16 of these types are defined. Examples include "no programme type", "Current affairs" and "Pop music", although the actual syntax which is displayed is determined by the software of the controlling microprocessor. In this example PTY can be displayed on request. Table 5 shows the display used for each PTY code.

Table 5. PTY Types

PTY	Display
0	no program type
1	News
2	Current affairs
3	Information
4	Sport
5	Education
6	Drama
7	Culture
8	Science
9	Varied
10	Pop music
11	Rock music
12	Easy listening
13	Light classics
14	Serious classics
15	Other music
16-31	no program type

TP is a single bit flag and is set if the transmitter normally carries traffic information. After PI, PTY and TP have been updated, the group type (A/B) and group number (0 to 15) are identified. Group types 0A, 0B, 1A, 1B, 2A, 4A, 14A, 14B and 15B are handled. Table 2 shows the type of information contained in each group and table 4 the detailed structure of the groups actually used. The different groups are treated as detailed below.

PS, AF, TA, M/S and DI (groups 0 and 15B)

PS is the eight-character name of the station and is permanently displayed (except in standby mode). In the absence of RDS (e.g., AM bands) this application allows the name to be manually entered. If none is entered, then the frequency is used as the station name when the program is stored in EEPROM. AF would be used by a car radio to retune to the strongest signal carrying the selected service. AF data, along with TDC and INH, is not used in this application. TA, like TP, is a flag. TP is permanently set if the transmitter normally carries traffic information and TA is set when a traffic announcement is actually in progress. The combination TA=1, TP=0 is used to indicate that EON data is being used to supply information on other networks including traffic announcements. A port line (port A, bit 5) is asserted (low) when TA=TP=1. This can be used to demute or switch from another source (e.g., cassette) when a traffic announcement occurs. M/S is a single bit indicating either music or speech and is intended to be used to make a tone or volume adjustment to a radio's audio stage. The M/S bit is displayed on request. A port line (port A, bit 6) is asserted (low) when M/S=1. This can be used to control external hardware. The ROMed PH8s (ZC428200 and ZC428202) do not include the TA=TP=1 and M/S outputs. Decoder information (DI) constitutes four bits indicating the type of transmission (mono, stereo, binaural etc.). It is not currently in use in the UK but can be displayed as a number between 0 and 15.

As AF data is not handled, there is no difference in the treatment of groups 0A and 0B. PS data is extracted and placed in RAM according to the address bits in block 2 (see table 4). TA, DI and MS data are then read, DI is sent a single bit at a time and uses the same address bits as the PS name to determine which of the four bits is being updated. Groups of type 15B also contains all this switching information. They are used to increase the repetition rate of this data but contain no PS or AF information.

PIN (group 1)

Programme item number or PIN is used to identify the programme currently being broadcast. The format is a 2-byte number which includes the scheduled time and date (day-of-month) of the start of the programme.

Group types 1A and 1B are again treated identically as they contain the same data except for the repetition of the PI code in type 1B. The PIN data is recovered and saved in RAM. This is intended for future use to control external hardware, for example a tape recorder. This would facilitate the unattended recording of a pre-selected program. At present this application simply allows the display of PIN data both in its raw hexadecimal form and fully decoded to day-of-month and time (see table 6). Full use of PIN data would require continuously comparing the PIN day-of-month and time with a manually entered day-of-month and time and asserting an output pin when there was a match.

RT (group 2A)

Radiotext (RT) constitutes a string of up to 64 characters which give additional information regarding the service or programme currently being transmitted. In this application, RT is displayed on request on the 16-digit dot-matrix displays using scrolling. RT data from blocks 3 and 4 is written to RAM according to the address included in block 2. There are 4 address bits and four ASCII encoded bytes giving the possibility of 64 characters. The data often contains extra spaces to centre the text on a 2x32 character display. As these are not appropriate for a 16-character scrolling display, the software reduces all sequences of two or more spaces to a single space. If the Text A/B flag changes state, the RT area in RAM is cleared as this indicates that the message has changed. Group 2B is not handled as it is rarely if ever used (2B or not 2B......).

Table 6. RDS display formats

RDS feature	Display format
CT date and time	Thu 12 May 21:35
PS name and CT time	4 BBC 4 FM 21:40
RT	Kaleidoscope ....
PTY	Culture
PI	PI code - C204
TA & TP	TP - 0 TA - 1
PIN(hex)	PIN no. - 655E
PIN(decoded)	12th at 21:30
MJD	MJ day - 49484
MS & DI	M/S M- DI 01
last TA 1	last TA PI C514
2	TA rtrn: EON PI
EON 1	BBC 3 FM 92.10
2	BBC Gael 103.70
3	BBC Nwcl 96.00
4	BBC Scot 94.30
5	BBC Scot 92.50
6	BBC Scot 94.70
7	BBC Scot 93.50
8	Classic 101.70
9	BBC Eng 107.90
10	BBC 1 FM 99.50
11	BBC 2 FM 89.90
12	BBC R5 909kHz
13	--------
14	--------
15	--------
16	--------

CT (group 4A)

CT data is transmitted every minute on the minute and facilitates a very accurate clock, traceable to national standards. The (Modified Julian) date and local time variation are also transmitted. Except in manual mode, when it is replaced with the frequency, the time is permanently displayed. In standby mode the date is displayed instead of the PS name (see table 6). The MJD number, which is the form in which the date is received, can also be displayed.

Two of the more complex tasks to be performed are required to process the CT data. These are for the local time difference and the conversion of the MJD number into a recognisable date. The broadcast time is Universal Co-ordinated Time (UTC, effectively the same as GMT). Time differences from UTC, including summer (daylight saving) time, are sent as an offset of up to +/- 12 hours in half-hour increments. The date is transmitted as the MJD (Modifier Julian Day) number and has to be converted to day-of-week, day-of-month, month and year using the formulae:

```
Y'        =   int[(MJD-15078.2)/365.25]

M'        =   int[(MJD-14956.1-int{Y'x365.25})/30.6001]

Day       =   MJD-14956-int(Y'x365.25)-int(M'x30.6001)

If M'=14 or M'=15, then K=1; else K=0

Year      =   Y'+K

Month     =   M'-1-12K
```

The third software module (Appendix 2) contains the 4-function 9-digit integer BCD arithmetic required to make the MJD calculations. The main code uses these routines to display the time and date in conventional form, adjusting the time (and perhaps the date) according to the local offset.

EON (group 14)

EON (Enhanced Other Networks) replaces the older ON format. If type 14 groups are used to provide EON data, then type 3 groups (ON) will not be used; table 2 shows the currently defined group types. Type 14A groups are used to send data about other networks. A large amount of EON information can be sent using this group. It takes up to two minutes for all the data to arrive after the radio has been retuned. This application saves the PI code, PS name and principal frequency of up to 16 networks although more networks, each with many frequencies, and other data (e.g., PTY(ON), PIN(ON), TA(ON) etc.) may be sent. Table 6 shows the format of the EON displays.

Type 14B groups are used to switch to traffic announcements on a different frequency. They include the PI code of the station carrying the announcement. This PI code is searched for in NVM and the required station tuned if it is stored in NVM. This method allows the user to select which TAs are allowed (they will not occur if the station is not in NVM or if its TA inhibit bit is set) and avoids attempts to jump to an announcement which is not relevant or not receivable with sufficient signal strength to be useful. The complete procedure is described below.

Traffic announcement procedure

The radio can respond to EON initiated traffic announcements if they are enabled by the TRAFFIC (TA) key. This status is indicated by a decimal point at the 11th character on the dot-matrix displays. A switch to a TA on another frequency will only occur if the station has previously been stored in NVM (the EON data which can be displayed using the RDS key is not used for TA switching). The PI code of the last TA (or attempted TA) can be displayed by pressing the RDS key eight times. A further press displays one of the TA return/inhibit messages shown below. TAs which are the result of TA=TP=1 on the current frequency do not update the last TA PI or TA return/inhibit messages.

When a 14B group is received the following occurs:

Check traffic flag; if enabled proceed, otherwise set TA rtrn/inhb message to:

```
TA inhb:  flag   - Traffic key inhibit flag (d.p. at the 11th character position).
```

Search for TA PI code in NVM; if found proceed, otherwise set TA rtrn/inhb message to:

```
TA inhb: EON PI  - The PI code given in 14B is not in the NVM.
```

Check station TA inhibit flag in NVM; if clear proceed, otherwise set TA rtrn/inhb message to:

```
TA inhb:   NVM   - User inhibit of station using bit stored in NVM.
```

Retune to frequency stored in NVM against EON PI code. The PS name display changes to show the PS name of the service carrying the traffic announcement and the time display is replaced by the new frequency. If the service has its TP flag high, then the 10s of kHz digit will flash as in the manual mode display. After one second, check TP flag at the new frequency. If high then proceed, otherwise return to original frequency and set TA rtrn/inhb message to:

```
TA rtrn: TP low  - TP station does not have TP bit high.
```

Check PI code at new frequency. If correct (same as 14B EON TA PI code) then proceed, otherwise retune to original frequency and set TA rtrn/inhb message to:

```
TA rtrn: PI code - PI code of TP station was not as expected.
```

After an additional 2 seconds, start to monitor the TA flag; if high, remain on current frequency, if low return to original frequency and set TA rtrn/inhb message to:

```
TA rtrn: TA low  - TA flag of TP station low. This is the normal return method.
```

If, during a TA, the radio is manually retuned, the TA rtrn/inhb message is set to:

```
TA rtrn: manual  -  User initiated manual return.
```

References

1 AN494/D, An HC11-controlled Multi-band RDS Radio.

2. CENELEC EN 50067, Specifications of the Radio Data System (RDS), formerly EBU Technical Document. 3244).

3. AN460/D, An RDS Decoder using the MC68HC05E0.

4. AN478/D, HC05 to HC11 code conversion.

5. EB419/D, ROMed HC11E32 and HC11PH8 including Buffalo monitor and PCbug11 talker.

Appendix 1

```
            *************************************************
            *                                               *
            *          MC68HC11E32 RDS Decoder.             *
            *                                               *
            *   Used with RADE.S11 FNCE.S11 & RDRAME.S11.   *
            *                                               *
            *    P. Topping           15th February '94     *
            *                                               *
            *************************************************

                    EXPORT  SDATA,TINTB,INITD,MOD,CLOCK,MJDAT,WAIT,CLREON,CBCD,PROC,TFCC

                    IMPORT  ADD,CLRAS,MJDC,DNAME,MNAME,DCON2,NEW,CLTR,SHAFT

                    LIB     RDRAME.S11

00000000    PORTA   EQU     $00             PORT A ADDRESS
00000004    PORTB   EQU     $04               "  B    "
00000003    PORTC   EQU     $03               "  C    "
00000008    PORTD   EQU     $08               "  D    "
0000000a    PORTE   EQU     $0A               "  E    "
00000007    PORTCD  EQU     $07             PORT C DATA DIRECTION REG.
00000009    PORTDD  EQU     $09               "  D "     "         "
00000024    TMSK2   EQU     $24
00000026    PACTL   EQU     $26
00000039    OPTION  EQU     $39
0000003d    INIT    EQU     $3D

00001000    RBO     EQU     $1000           REGISTER BLOCK OFFSET
0000003b    PPROG   EQU     $3B             EEPROM CONTROL REGISTER
00000009    ND      EQU     9               No. DIGITS

                    SECTION.S .RAM1,COMM

00000000    BMJD    RMB     3               BINARY MJD
00000003    Q       RMB     9               WORKING NUMBER 1 - RDS
0000000c    TMQ     RMB     9               SCRATCH
00000015    P       RMB     9               WORKING NUMBER 2 - RDS
0000001e    TMP     RMB     9               MULT. OVER. OR DIV. REMAINDER
00000027    R       RMB     9               WORKING NUMBER 3 - RDS
00000030    MJD     RMB     9               MODIFIED JULIAN DAY NUMBER
00000039    YR      RMB     9               YEAR
00000042    MNTH    RMB     2               MONTH
00000044    DOM     RMB     2               DATE
00000046    DOW     RMB     1               DAY OF WEEK

            *****************************************
            *                                       *
            *      RAM allocation, RDS & radio.     *
            *                                       *
            *****************************************

00000047    DIST    RMB     1               TRANSIENT DISPLAY TIMEOUT COUNTER
00000048    SLEPT   RMB     1               SLEEP TIMER MINUTES COUNTER
00000049    RDSTO   RMB     1               RDS TIMEOUT COUNTER
0000004a    PSNP    RMB     1               PS DISPLAY POINTER
0000004b    DAT     RMB     4               SERIAL DATA BUFFER
0000004f    TMPGRP  RMB     8               TEMPORARY GROUP DATA
00000057    GROUP   RMB     8               COMPLETE GROUP DATA
0000005f    PTY     RMB     1               PROGRAM-TYPE CODE (CURRENT)
00000060    PTYCMP  RMB     1               PROGRAM-TYPE CODE (PTY SCAN)
00000061    PI      RMB     2               PROGRAM IDENTIFICATION CODE
00000063    PION    RMB     2               PROGRAM IDENTIFICATION CODE (EON)
00000065    PIN     RMB     2               PROGRAM ITEM NUMBER
00000067    LEV     RMB     1               VALID BLOCK LEVEL
00000068    BIT     RMB     1               BIT LEVEL
00000069    ITMP1   RMB     1               TEMP BYTE FOR USE IN IRQ
0000006a    SYN     RMB     2               SYNDROME
0000006c    CONF    RMB     1               SYNDROME CONFIDENCE
0000006d    TH32    RMB     1               TICS (SECONDS/32)
0000006e    TH8     RMB     1               EIGHTHS OF SECONDS
0000006f    SEC     RMB     1               SECONDS
00000070    MIN     RMB     1               MINUTES
00000071    OUR     RMB     1               HOURS
00000072    AMIN    RMB     1               ALARM MINUTES
00000073    AOUR    RMB     1               ALARM HOURS
00000074    DISP1   RMB     1               RT DISPLAY POINTER #1
00000075    DISP2   RMB     1               RT DISPLAY POINTER #2

00000076    RQ      RMB     6               WORKING BCD NUMBER 1 RADIO
0000007c    RP      RMB     6                  "     "    "    2   "
00000082    RR      RMB     6                  "     "    "    3   "
00000088    W1      RMB     2               W
0000008a    W2      RMB     2               O
0000008c    W3      RMB     2               R
0000008e    W4      RMB     2               K
00000090    W5      RMB     2               I
00000092    W6      RMB     2               N
00000094    W7      RMB     2               G
00000096    KEY     RMB     1               CODE OF PRESSED KEY
00000097    KOUNT   RMB     1               KEYBOARD COUNTER
00000098    DIG2    RMB     1               2nd DIGIT TIMEOUT COUNTER
00000099    CARRY   RMB     1               BCD CARRY
0000009a    COUNT   RMB     1               LOOP COUNTER
0000009b    NUM1    RMB     2               1ST No. POINTER (ADD & SUBTRACT)
0000009d    NUM2    RMB     2               2ND No. POINTER (ADD & SUBTRACT)
0000009f    LED     RMB     1               STATION NUMBER
000000a0    SMEM    RMB     2               CURRENT FREQUENCY
000000a2    REARET  RMB     1               LAST TA REASON FOR RETURN
000000a3    RTDIS   RMB     1               RDS DISPLAY TYPE
000000a4    DI      RMB     1               DECODER IDENTIFICATION
000000a5    SCHAN   RMB     1               SCAN CHANNEL
```

```
                        **********************************************
                        *                                            *
                        *       Flags, & pages 1-2.                  *
                        *                                            *
                        **********************************************

000000a6                STAT    RMB     1               0: MODE 1: STATION, 0: FREQ
                        *                               1: STEP 1: 50KHz, 0: 10KHz
                        *                               2: CLRQ 1: CLEAR IF NO. KEYED
                        *                               3: TIMER MS BIT TOGGLE (64 Hz)
                        *                               4: RDS DATA CLEARING ENABLE
                        *                               5: KEY FUNCTION PERFORMED
                        *                               6: KEY REPEATING
                        *                               7: NOT JUST POWERED UP
000000a7                STAT2   RMB     1               0: VALID SYNDROME
                        *                               1: VALID GROUP
                        *                               2: RT DISPLAY
                        *                               3: UPDATE DISPLAY
                        *                               4: CLEAR DISPLAY
                        *                               5: SPACE FLAG
                        *                               6: NOT ON PROGRAM (AM)
                        *                               7: TA RETUNE DONE
000000a8                STAT3   RMB     1               0: NOT ON PROGRAM (FM)
                        *                               1: TEXTA/TEXTB BIT (RT)
                        *                               2: TA FLAG
                        *                               3: TP FLAG
                        *                               4: SHAFT DIRECTION
                        *                               5: SHAFT ROTATION
                        *                               6: UPDATE DATE
                        *                               7: SHAFT INTERRUPTS
000000a9                STAT4   RMB     1               0: DISPLAY (OR TA SWITCH) TRANSIENT
                        *                               1: SLEEP TIMER RUNNING
                        *                               2: TRAFFIC ENABLED
                        *                               3: ALARM DISPLAY
                        *                               4: ALARM ARMED
                        *                               5: ALARM SET-UP
                        *                               6: ALARM HOURS (SET-UP)
                        *                               7: VALID GROUP 14B RECEIVED
000000aa                STAT5   RMB     1               0: BAND CHANGE TIMEOUT
                        *                               1: RDS DISPLAYS
                        *                               2: SLEEP DISPLAY
                        *                               3: M/S 0: M, 1: S
                        *                               4: RETUNE FLAG (FREQUENCY MODE)
                        *                               5: TA INHIBIT FLAG (NVM)
                        *                               6: STORE MODE
                        *                               7: WEEKDAY ONLY ALARM

000000ab                STAT6   RMB     1               BAND/BANK (,MW STEP,COLON, ,A1,A0,,E6)
000000ac                BCTO    RMB     1               BAND CHANGE TIMEOUT
000000ad                SCNT    RMB     1               SHAFT DETENT COUNTER

                                SECTION .RAM2,COMM
00000000                EON     RMB     256             EON DATA (16 NETWORKS)
                                SECTION .RAM3,COMM
00000000                DISP    RMB     16              LCD MODULE BUFFER
00000010                DISPP   RMB     16              CURRENT LCD MODULE CONTENTS
00000020                PSN     RMB     8
00000028                RT      RMB     69              RADIOTEXT

                                SECTION .ROM3

                        ************************************************
                        *                                              *
                        *       Timer interrupt routine.               *
                        *                                              *
                        ************************************************

00000000 >7c0000        TINTB   INC     TH32
00000003 >9600                  LDAA    TH32
00000005  8104                  CMPA    #4
00000007  2709                  BEQ     FOUR
00000009  18ce1000              LDY     #$1000
0000000d  181d25bf              BCLR    $25,Y,$BF               CLEAR RTI INTERRUPT FLAG
00000011  3b                    RTI

00000012 >7f0000        FOUR    CLR     TH32
00000015 >7c0000                INC     DISP1                     DISP1    DISP2    DISPLAY
00000018 >9600                  LDAA    DISP1                    0 -  8        0
0000001a  8108                  CMPA    #8                       9 - 78   1 - 70    MOVING RT
0000001c  2307                  BLS     NWR                     78 - 88       70    END OF RT
0000001e  814e                  CMPA    #78
00000020  2203                  BHI     NWR                     END OF RADIOTEXT ?
00000022 >7c0000                INC     DISP2                   NO, MOVE RADIOTEXT ONE CHARACTER
00000025  8158          NWR     CMPA    #88                     2 SECONDS AT END OF RADIOTEXT
00000027  2503                  BLO     NWR2
00000029 >150004                BCLR    STAT2,$04               RETURN TO NORMAL DISPLAY
0000002c >140008        NWR2    BSET    STAT2,$08               UPDATE DISPLAY
0000002f  18ce1000              LDY     #$1000
00000033  181d25bf              BCLR    $25,Y,$BF               CLEAR RTI INTERRUPT FLAG

00000037 >7c0000        CLCK    INC     TH8                     UPDATE EIGHTHS OF SECONDS
0000003a >7a0000                DEC     DIG2                    DECREMENT 2nd DIGIT TIMEOUT
0000003d >7a0000                DEC     DIST                    DECREMENT TRANSEINT DISPLAY TIMER
00000040 >7c0000                INC     RDSTO
00000043 >9600                  LDAA    RDSTO
00000045  8150                  CMPA    #80                     10s WITHOUT A GROUP 0 OR 15 ?
00000047  251d                  BLO     RDSOK
00000049 >150004                BCLR    STAT3,$04               YES, CLEAR TA FLAG
0000004c >13008003              BRCLR   STAT4,$80,N14B          14B ?
00000050 >150080                BCLR    STAT4,$80               AND 14B ?
00000053 >7f0000        N14B    CLR     PI                      CLEAR
00000056 >7f0001                CLR     PI+1                    PI CODE
00000059 >12001009              BRSET   STAT,$10,RDSOK          RDS DATA ALREADY CLEARED ?
0000005d >140010                BSET    STAT,$10                NO, DOING IT THIS TIME
00000060 >bd0000                JSR     CLREON                  CLEAR EON DATA AND
00000063 >140010                BSET    STAT2,$10               INITIALISE OTHER RDS DATA
```

```
                              **************************************************
                              *                                                *
                              *       Update clock.                            *
                              *                                                *
                              **************************************************

00000066 >9600                RDSOK   LDAA    TH8                     EIGHTHS OF SECONDS
00000068  8108                        CMPA    #8
0000006a  263e                        BNE     NOTC                    PAST 7 ?
0000006c >7f0000                      CLR     TH8                     YES, CLEAR
0000006f >7c0000                      INC     SEC                     UPDATE SECONDS
00000072 >9600                        LDAA    SEC
00000074  8101                        CMPA    #1
00000076  2603                        BNE     NOTS
00000078 >7a0000                      DEC     SLEPT                   DECREMENT SLEEP TIMER MINUTES
0000007b  813c                NOTS    CMPA    #60
0000007d  262b                        BNE     NOTC                    PAST 59 ?
0000007f >7f0000                      CLR     SEC                     YES, CLEAR
00000082 >7c0000                      INC     MIN                     UPDATE MINUTES
00000085 >9600                        LDAA    MIN
00000087  813c                        CMPA    #60
00000089  261f                        BNE     NOTC                    PAST 59 ?
0000008b >7f0000                      CLR     MIN                     YES, CLEAR
0000008e >7c0000                      INC     OUR                     UPDATE HOURS
00000091 >9600                        LDAA    OUR
00000093  8118                        CMPA    #24
00000095  2613                        BNE     NOTC                    PAST 23 ?
00000097 >7f0000                      CLR     OUR                     YES CLEAR
0000009a >7c0002                      INC     BMJD+2
0000009d  2608                        BNE     NOTD
0000009f >7c0001                      INC     BMJD+1
000000a2  2603                        BNE     NOTD
000000a4 >7c0000                      INC     BMJD
000000a7 >140040              NOTD    BSET    STAT3,$40               UPDATE DATE
000000aa  3b                  NOTC    RTI

                              **************************************************
                              *                                                *
                              *       Toggle flashing colon control bit.       *
                              *                                                *
                              **************************************************

000000ab >12002004            TFCC    BRSET   STAT6,$20,CCBH
000000af >140020                      BSET    STAT6,$20
000000b2  39                          RTS
000000b3 >150020              CCBH    BCLR    STAT6,$20
000000b6  39                  .       RTS

                              **************************************************
                              *                                                *
                              *       RDS clock (FM) or SHAFT (AM) interrupt.  *
                              *                                                *
                              **************************************************

000000b7  18ce1000            SDATA   LDY     #$1000
000000bb  181f000807                  BRCLR   PORTA,Y,$08,RDSD        RDS INTERRUPTS ONLY (A3) ?
000000c0 >13008003                    BRCLR   STAT3,$80,RDSD          NO, USE CONTROL BIT FROM BAND INPUTS
000000c4 >7e0000                      JMP     SHAFT                   NO, INTERRUPT FROM SHAFT
000000c7 >1200081c            RDSD    BRSET   STAT6,$08,NOTFM         RDS, BUT IS IT AN FM BAND ?
000000cb  0d                          SEC                             YES
000000cc  181e0a2001                  BRSET   PORTE,Y,$20,DHIGH
000000d1  0c                          CLC
000000d2 >790003              DHIGH   ROL     DAT+3
000000d5 >790002                      ROL     DAT+2
000000d8 >790001                      ROL     DAT+1
000000db >790000                      ROL     DAT
000000de >1300010a                    BRCLR   STAT2,$01,TRY2          BIT BY BIT CHECK ?
000000e2 >7a0000                      DEC     BIT                     NO, WAIT FOR BIT 26
000000e5  2701                        BEQ     TRY1                    THIS TIME ?
000000e7  3b                  NOTFM   RTI

000000e8  861a                TRY1    LDAA    #26
000000ea >9700                        STAA    BIT
000000ec >9601                TRY2    LDAA    DAT+1                   LSB
000000ee >d600                        LDAB    DAT                     MSB (2 BITS)
000000f0  c403                        ANDB    #3

000000f2 >13030104            S03     BRCLR   DAT+3,$01,S13
000000f6  881b                        EORA    #$1B
000000f8  c803                        EORB    #$03

000000fa >13030204            S13     BRCLR   DAT+3,$02,S23
000000fe  888f                        EORA    #$8F
00000100  c803                        EORB    #$03

00000102 >13030404            S23     BRCLR   DAT+3,$04,S33
00000106  88a7                        EORA    #$A7
00000108  c802                        EORB    #$02

0000010a >13030802            S33     BRCLR   DAT+3,$08,S43
0000010e  88f7                        EORA    #$F7

00000110 >13031004            S43     BRCLR   DAT+3,$10.S53
00000114  88ee                        EORA    #$EE
00000116  c801                        EORB    #$01

00000118 >13032004            S53     BRCLR   DAT+3,$20,S63
0000011c  88dc                        EORA    #$DC
0000011e  c803                        EORB    #$03
```

```
                             **************************************************
                             *                                                *
                             *       Calculate syndrome (cont.).              *
                             *                                                *
                             **************************************************

00000120 >13034004           S63     BRCLR   DAT+3,$40,S73
00000124  8801                       EORA    #$01
00000126  c802                       EORB    #$02

00000128 >13038004           S73     BRCLR   DAT+3,$80,S02
0000012c  88bb                       EORA    #$BB
0000012e  c801                       EORB    #$01

00000130 >13020104           S02     BRCLR   DAT+2,$01,S12
00000134  8876                       EORA    #$76
00000136  c803                       EORB    #$03

00000138 >13020204           S12     BRCLR   DAT+2,$02,S22
0000013c  8855                       EORA    #$55
0000013e  c803                       EORB    #$03

00000140 >13020404           S22     BRCLR   DAT+2,$04,S32
00000144  8813                       EORA    #$13
00000146  c803                       EORB    #$03

00000148 >13020804           S32     BRCLR   DAT+2,$08,S42
0000014c  889f                       EORA    #$9F
0000014e  c803                       EORB    #$03

00000150 >13021004           S42     BRCLR   DAT+2,$10,S52
00000154  8887                       EORA    #$87
00000156  c802                       EORB    #$02

00000158 >13022002           S52     BRCLR   DAT+2,$20,S62
0000015c  88b7                       EORA    #$B7

0000015e >13024004           S62     BRCLR   DAT+2,$40,S72
00000162  886e                       EORA    #$6E
00000164  c801                       EORB    #$01

00000166 >13028004           S72     BRCLR   DAT+2,$80,FIN
0000016a  88dc                       EORA    #$DC
0000016c  c802                       EORB    #$02

0000016e >d700               FIN     STAB    SYN
00000170 >9701                       STAA    SYN+1

                             **************************************************
                             *                                                *
                             *       Check for syndromes A, B, C & C'.        *
                             *                                                *
                             **************************************************

00000172 >9600                       LDAA    LEV
00000174  8103                       CMPA    #3
00000176  2764                       BEQ     TRYD
00000178  8102                       CMPA    #2
0000017a  2723                       BEQ     TRYC
0000017c  8101                       CMPA    #1
0000017e  2711                       BEQ     TRYB
00000180 >7f0000                     CLR     LEV

00000183 >9601               TRYA    LDAA    SYN+1                    BLOCK 1
00000185  81d8                       CMPA    #$D8
00000187  2632                       BNE     NOTV
00000189 >9600                       LDAA    SYN
0000018b  8103                       CMPA    #$03
0000018d  262c                       BNE     NOTV
0000018f  205d                       BRA     VALID

00000191 >9601               TRYB    LDAA    SYN+1                    BLOCK 2
00000193  81d4                       CMPA    #$D4
00000195  2624                       BNE     NOTV
00000197 >9600                       LDAA    SYN
00000199  8103                       CMPA    #$03
0000019b  261e                       BNE     NOTV
0000019d  204f                       BRA     VALID

0000019f >1202080c           TRYC    BRSET   TMPGRP+2,$08,TRYCD       BLOCK 3 TYPE A
000001a3 >9601                       LDAA    SYN+1
000001a5  815c                       CMPA    #$5C
000001a7  2612                       BNE     NOTV
000001a9 >9600                       LDAA    SYN
000001ab  8102                       CMPA    #$02
000001ad  200a                       BRA     VC

000001af >9601               TRYCD   LDAA    SYN+1                    BLOCK 3 TYPE B
000001b1  81cc                       CMPA    #$CC
000001b3  2606                       BNE     NOTV
000001b5 >9600                       LDAA    SYN
000001b7  8103                       CMPA    #$03
000001b9  2733               VC      BEQ     VALID
```

```
                            **************************************************
                            *                                                *
                            *       Invalid syndrome handling, check for     *
                            *       block 4 and save group data if valid.    *
                            *                                                *
                            **************************************************

000001bb >7f0000            NOTV    CLR     LEV                 RESTART AT BLOCK 1
000001be >9600                      LDAA    CONF
000001c0  8129                      CMPA    #41                 CONFIDENCE 41 OR GREATER ?
000001c2  2410                      BHS     DECC
000001c4 >150001                    BCLR    STAT2,$01           BIT BY BIT SYNDROME CHECK
000001c7  810a                      CMPA    #10
000001c9  230d                      BLS     SKPDC               CONFIDENCE 10 OR LESS ?
000001cb >7a0000                    DEC     BIT
000001ce  2607                      BNE     NNOW                USE BIT COUNTER TO SLOW CONFIDENCE
000001d0  861a                      LDAA    #26                 DROP DURING BIT BY BIT ATTEMPT TO
000001d2 >9700                      STAA    BIT                 RE-SYNCRONISE
000001d4 >7a0000            DECC    DEC     CONF
000001d7  3b                NNOW    RTI
000001d8 >140010            SKPDC   BSET    STAT2,$10           10 OR LESS, INITIALISE DISPLAY
000001db  3b                NOT4    RTI

000001dc >9601              TRYD    LDAA    SYN+1
000001de  8158                      CMPA    #$58
000001e0  26d9                      BNE     NOTV
000001e2 >9600                      LDAA    SYN
000001e4  8102                      CMPA    #$02
000001e6  26d3                      BNE     NOTV
000001e8 >140002                    BSET    STAT2,$02           GROUP COMPLETE
000001eb >150010                    BCLR    STAT,$10            RE-ENABLE RDS DATA CLEARING

000001ee >12000107          VALID   BRSET   STAT2,$01.VLD
000001f2  8626                      LDAA    #38
000001f4 >9700                      STAA    CONF
000001f6 >140001                    BSET    STAT2,$01
000001f9 >9600              VLD     LDAA    CONF
000001fb  8138                      CMPA    #56
000001fd  2204                      BHI     NMR
000001ff  8b04                      ADDA    #4
00000201 >9700                      STAA    CONF
00000203  ce0000            NMR     LDX     #0
00000206 >d600                      LDAB    LEV
00000208  59                        ROLB
00000209  3a                        ABX
0000020a >7c0000                    INC     LEV
0000020d  861a                      LDAA    #26
0000020f >9700                      STAA    BIT
00000211 >760000                    ROR     DAT
00000214 >760001                    ROR     DAT+1
00000217 >760002                    ROR     DAT+2
0000021a >760000                    ROR     DAT
0000021d >760001                    ROR     DAT+1
00000220 >760002                    ROR     DAT+2
00000223 >9602                      LDAA    DAT+2
00000225 >a701                      STAA    TMPGRP+1,X
00000227 >9601                      LDAA    DAT+1
00000229 >a700                      STAA    TMPGRP,X
0000022b >130002ac                  BRCLR   STAT2,$02,NOT4      GROUP COMPLETE ?
0000022f  ce0008            XFER    LDX     #8
00000232 >a6ff              TXLP    LDAA    TMPGRP-1,X
00000234 >a7ff                      STAA    GROUP-1,X
00000236  09                        DEX
00000237  26f9                      BNE     TXLP
                            *        RTL

                            **************************************************
                            *                                                *
                            *       Update PI code, initialise if changed.   *
                            *       All block 1s used, block 3s not used.    *
                            *                                                *
                            **************************************************

00000239 >9600              PROC    LDAA    GROUP               COMPARE PI WITH PREVIOUS
0000023b >9100                      CMPA    PI
0000023d  2606                      BNE     DNDX
0000023f >9601                      LDAA    GROUP+1
00000241 >9101                      CMPA    PI+1
00000243  270e                      BEQ     PTYL
00000245 >9600              DNDX    LDAA    GROUP               DIFFERENT, SAVE NEW PI
00000247 >9700                      STAA    PI
00000249 >9601                      LDAA    GROUP+1
0000024b >9701                      STAA    PI+1
0000024d >bd0000                    JSR     CLREON
00000250 >140010                    BSET    STAT2,$10           INITIALISE DISPLAY DATA

                            **************************************************
                            *                                                *
                            *       Update PTY and TP.                       *
                            *       All block 2s used, not block 4 (grp 15B). *
                            *                                                *
                            **************************************************

00000253 >9602              PTYL    LDAA    GROUP+2
00000255 >9700                      STAA    ITMP1
00000257 >13000405                  BRCLR   ITMP1,$04,TPL1      TP HIGH ?
0000025b >140008                    BSET    STAT3,$08           YES, FLAG HIGH
0000025e  2003                      BRA     TPL
00000260 >150008            TPL1    BCLR    STAT3,$08           NO, FLAG LOW
00000263 >9603              TPL     LDAA    GROUP+3
00000265 >760000                    ROR     ITMP1
00000268  46                        RORA
00000269  44                        LSRA
0000026a  44                        LSRA
0000026b  44                        LSRA
0000026c  44                        LSRA
0000026d >9700                      STAA    PTY
```

```
                          **************************************************
                          *                                                *
                          *       Groups handled.                          *
                          *                                                *
                          *       All                 PI, PTY & TP         *
                          *       0 A & B     TA, PS, DI, M/S (not AF)     *
                          *       1 A & B     PIN                          *
                          *       2 A         RT                           *
                          *       4 A         CT                           *
                          *      14 A & B     EON (TP only)                *
                          *      15 B         TA                           *
                          *                                                *
                          **************************************************

                          **************************************************
                          *                                                *
                          *       Process groups 0 & 15B (PS & TA).        *
                          *                                                *
                          **************************************************

0000026f >9602                    LDAA    GROUP+2
00000271  84f8                    ANDA    #$F8
00000273  270a                    BEQ     GRP0                    GROUP 0A
00000275  8108                    CMPA    #$08                    GROUP 0B
00000277  2706                    BEQ     GRP0

00000279  81f8            TGRP15  CMPA    #$F8                    GROUP 15B
0000027b  2713                    BEQ     TACK
0000027d  2077                    BRA     PROC1

0000027f >d603            GRP0    LDAB    GROUP+3                 GROUP 0  -  PS & TA
00000281  c403                    ANDB    #$03
00000283  58                      LSLB
00000284 >ce0000                  LDX     #PSN
00000287  3a                      ABX
00000288 >9606                    LDAA    GROUP+6
0000028a  a700                    STAA    0,X
0000028c >9607                    LDAA    GROUP+7
0000028e  a701                    STAA    1,X

00000290 >7f0000          TACK    CLR     RDSTO                   RDS OK, RESET TIME-OUT
00000293 >12031014                BRSET   GROUP+3,$10,TAH         TA HIGH ?
00000297 >150004                  BCLR    STAT3,$04               NO, TA FLAG LOW
0000029a >13008010                BRCLR   STAT2,$80,NTD           SWITCHED TO TA ?
0000029e >1200010c                BRSET   STAT4,$01,NTD           3s LOCKOUT TIMEOUT FINISHED ?
000002a2 >150080                  BCLR    STAT4,$80               YES, SWITCH BACK TO NORMAL PROG.
000002a5  8604                    LDAA    #4
000002a7 >9700                    STAA    REARET
000002a9  2003                    BRA     NTD
000002ab >140004          TAH     BSET    STAT3,$04               YES, TA FLAG HIGH

                          **************************************************
                          *                                                *
                          *       Process groups 0 & 15B (DI & M/S).       *
                          *                                                *
                          **************************************************

000002ae >d603            NTD     LDAB    GROUP+3                 DI
000002b0  c403                    ANDB    #3
000002b2 >9603                    LDAA    GROUP+3
000002b4  8404                    ANDA    #$04
000002b6  5d                      TSTB
000002b7  2609                    BNE     NOT0
000002b9 >150008                  BCLR    DI,#8
000002bc  4d                      TSTA
000002bd  2703                    BEQ     NOT0
000002bf >140008                  BSET    DI,#8
000002c2  c101            NOT0    CMPB    #1
000002c4  2609                    BNE     NOT1
000002c6 >150004                  BCLR    DI,#4
000002c9  4d                      TSTA
000002ca  2703                    BEQ     NOT1
000002cc >140004                  BSET    DI,#4
000002cf  c102            NOT1    CMPB    #2
000002d1  2609                    BNE     NOT2
000002d3 >150002                  BCLR    DI,#2
000002d6  4d                      TSTA
000002d7  2703                    BEQ     NOT2
000002d9 >140002                  BSET    DI,#2
000002dc  c103            NOT2    CMPB    #3
000002de  2609                    BNE     NOT3
000002e0 >150001                  BCLR    DI,#1
000002e3  4d                      TSTA
000002e4  2703                    BEQ     NOT3
000002e6 >140001                  BSET    DI,#1

000002e9 >150008          NOT3    BCLR    STATS,$08               M/S
000002ec >13030803                BRCLR   GROUP+3,#$08,MSZ
000002f0 >140008                  BSET    STATS,$08
000002f3 >7e0000          MSZ     JMP     OUT1
```

```
                             **************************************************
                             *                                                *
                             *      Invalid syndrome handling, check for      *
                             *      block 4 and save group data if valid.     *
                             *                                                *
                             **************************************************

000001bb >7f0000             NOTV    CLR    LEV                    RESTART AT BLOCK 1
000001be >9600                       LDAA   CONF
000001c0  8129                       CMPA   #41                    CONFIDENCE 41 OR GREATER ?
000001c2  2410                       BHS    DECC
000001c4 >150001                     BCLR   STAT2,$01              BIT BY BIT SYNDROME CHECK
000001c7  810a                       CMPA   #10
000001c9  230d                       BLS    SKPDC                  CONFIDENCE 10 OR LESS ?
000001cb >7a0000                     DEC    BIT
000001ce  2607                       BNE    NNOW                   USE BIT COUNTER TO SLOW CONFIDENCE
000001d0  861a                       LDAA   #26                    DROP DURING BIT BY BIT ATTEMPT TO
000001d2 >9700                       STAA   BIT                    RE-SYNCRONISE
000001d4 >7a0000             DECC    DEC    CONF
000001d7  3b                 NNOW    RTI
000001d8 >140010             SKPDC   BSET   STAT2,$10              10 OR LESS, INITIALISE DISPLAY
000001db  3b                 NOT4    RTI

000001dc >9601               TRYD    LDAA   SYN+1
000001de  8158                       CMPA   #$58
000001e0  26d9                       BNE    NOTV
000001e2 >9600                       LDAA   SYN
000001e4  8102                       CMPA   #$02
000001e6  26d3                       BNE    NOTV
000001e8 >140002                     BSET   STAT2,$02              GROUP COMPLETE
000001eb >150010                     BCLR   STAT,$10               RE-ENABLE RDS DATA CLEARING

000001ee >12000107           VALID   BRSET  STAT2,$01.VLD
000001f2  8626                       LDAA   #38
000001f4 >9700                       STAA   CONF
000001f6 >140001                     BSET   STAT2,$01
000001f9 >9600               VLD     LDAA   CONF
000001fb  8138                       CMPA   #56
000001fd  2204                       BHI    NMR
000001ff  8b04                       ADDA   #4
00000201 >9700                       STAA   CONF
00000203  ce0000             NMR     LDX    #0
00000206 >d600                       LDAB   LEV
00000208  59                         ROLB
00000209  3a                         ABX
0000020a >7c0000                     INC    LEV
0000020d  861a                       LDAA   #26
0000020f >9700                       STAA   BIT
00000211 >760000                     ROR    DAT
00000214 >760001                     ROR    DAT+1
00000217 >760002                     ROR    DAT+2
0000021a >760000                     ROR    DAT
0000021d >760001                     ROR    DAT+1
00000220 >760002                     ROR    DAT+2
00000223 >9602                       LDAA   DAT+2
00000225 >a701                       STAA   TMPGRP+1,X
00000227 >9601                       LDAA   DAT+1
00000229 >a700                       STAA   TMPGRP,X
0000022b >130002ac                   BRCLR  STAT2,$02,NOT4         GROUP COMPLETE ?
0000022f  ce0008             XFER    LDX    #8
00000232 >a6ff               TXLP    LDAA   TMPGRP-1,X
00000234 >a7ff                       STAA   GROUP-1,X
00000236  09                         DEX
00000237  26f9                       BNE    TXLP
                             *        RTI

                             **************************************************
                             *                                                *
                             *      Update PI code, initialise if changed.    *
                             *      All block 1s used, block 3s not used.     *
                             *                                                *
                             **************************************************

00000239 >9600               PROC    LDAA   GROUP                  COMPARE PI WITH PREVIOUS
0000023b >9100                       CMPA   PI
0000023d  2606                       BNE    DNDX
0000023f >9601                       LDAA   GROUP+1
00000241 >9101                       CMPA   PI+1
00000243  270e                       BEQ    PTYL
00000245 >9600               DNDX    LDAA   GROUP                  DIFFERENT, SAVE NEW PI
00000247 >9700                       STAA   PI
00000249 >9601                       LDAA   GROUP+1
0000024b >9701                       STAA   PI+1
0000024d >bd0000                     JSR    CLREON
00000250 >140010                     BSET   STAT2,$10              INITIALISE DISPLAY DATA

                             **************************************************
                             *                                                *
                             *      Update PTY and TP.                        *
                             *      All block 2s used, not block 4 (grp 15B). *
                             *                                                *
                             **************************************************

00000253 >9602               PTYL    LDAA   GROUP+2
00000255 >9700                       STAA   ITMP1
00000257 >13000405                   BRCLR  ITMP1,$04,TPL1         TP HIGH ?
0000025b >140008                     BSET   STAT3,$08              YES, FLAG HIGH
0000025e  2003                       BRA    TPL
00000260 >150008             TPL1    BCLR   STAT3,$08              NO, FLAG LOW
00000263 >9603               TPL     LDAA   GROUP+3
00000265 >760000                     ROR    ITMP1
00000268  46                         RORA
00000269  44                         LSRA
0000026a  44                         LSRA
0000026b  44                         LSRA
0000026c  44                         LSRA
0000026d >9700                       STAA   PTY
```

```
                              ************************************************
                              *                                              *
                              *       Groups handled.                        *
                              *                                              *
                              *       All               PI, PTY & TP         *
                              *       0 A & B     TA, PS, DI, M/S (not AF)   *
                              *       1 A & B     PIN                        *
                              *       2 A         RT                         *
                              *       4 A         CT                         *
                              *      14 A & B     EON (TP only)              *
                              *      15 B         TA                         *
                              *                                              *
                              ************************************************

                              ************************************************
                              *                                              *
                              *       Process groups 0 & 15B (PS & TA).      *
                              *                                              *
                              ************************************************

0000026f >9602                        LDAA   GROUP+2
00000271  84f8                        ANDA   #$F8
00000273  270a                        BEQ    GRP0                 GROUP 0A
00000275  8108                        CMPA   #$08                 GROUP 0B
00000277  2706                        BEQ    GRP0

00000279  81f8                TGRP15  CMPA   #$F8                 GROUP 15B
0000027b  2713                        BEQ    TACK
0000027d  2077                        BRA    PROC1

0000027f >d603                GRP0    LDAB   GROUP+3              GROUP 0  -  PS & TA
00000281  c403                        ANDB   #$03
00000283  58                          LSLB
00000284 >ce0000                      LDX    #PSN
00000287  3a                          ABX
00000288 >9606                        LDAA   GROUP+6
0000028a  a700                        STAA   0,X
0000028c >9607                        LDAA   GROUP+7
0000028e  a701                        STAA   1,X

00000290 >7f0000              TACK    CLR    RDSTO                RDS OK, RESET TIME-OUT
00000293 >12031014                    BRSET  GROUP+3,$10,TAH      TA HIGH ?
00000297 >150004                      BCLR   STAT3,$04            NO, TA FLAG LOW
0000029a >13008010                    BRCLR  STAT2,$80,NTD        SWITCHED TO TA ?
0000029e >1200010c                    BRSET  STAT4,$01,NTD        3s LOCKOUT TIMEOUT FINISHED ?
000002a2 >150080                      BCLR   STAT4,$80            YES, SWITCH BACK TO NORMAL PROG.
000002a5  8604                        LDAA   #4
000002a7 >9700                        STAA   REARET
000002a9  2003                        BRA    NTD
000002ab >140004              TAH     BSET   STAT3,$04            YES, TA FLAG HIGH

                              ************************************************
                              *                                              *
                              *       Process groups 0 & 15B (DI & M/S).     *
                              *                                              *
                              ************************************************

000002ae >d603                NTD     LDAB   GROUP+3              DI
000002b0  c403                        ANDB   #3
000002b2 >9603                        LDAA   GROUP+3
000002b4  8404                        ANDA   #$04
000002b6  5d                          TSTB
000002b7  2609                        BNE    NOT0
000002b9 >150008                      BCLR   DI,#8
000002bc  4d                          TSTA
000002bd  2703                        BEQ    NOT0
000002bf >140008                      BSET   DI,#8
000002c2  c101                NOT0    CMPB   #1
000002c4  2609                        BNE    NOT1
000002c6 >150004                      BCLR   DI,#4
000002c9  4d                          TSTA
000002ca  2703                        BEQ    NOT1
000002cc >140004                      BSET   DI,#4
000002cf  c102                NOT1    CMPB   #2
000002d1  2609                        BNE    NOT2
000002d3 >150002                      BCLR   DI,#2
000002d6  4d                          TSTA
000002d7  2703                        BEQ    NOT2
000002d9 >140002                      BSET   DI,#2
000002dc  c103                NOT2    CMPB   #3
000002de  2609                        BNE    NOT3
000002e0 >150001                      BCLR   DI,#1
000002e3  4d                          TSTA
000002e4  2703                        BEQ    NOT3
000002e6 >140001                      BSET   DI,#1

000002e9 >150008              NOT3    BCLR   STATS,$08            M/S
000002ec >13030803                    BRCLR  GROUP+3,#$08,MSZ
000002f0 >140008                      BSET   STATS,$08
000002f3 >7e0000              MSZ     JMP    OUT1
```

```
                          *****************************************************
                          *                                                   *
                          *       Process group 1 (PIN).                      *
                          *                                                   *
                          *****************************************************

000002f6  8110            PROC1   CMPA    #$10                    GROUP 1A
000002f8  2704                    BEQ     GRP1
000002fa  8118                    CMPA    #$18                    GROUP 1B
000002fc  260b                    BNE     PROC2

000002fe >9606            GRP1    LDAA    GROUP+6
00000300 >9700                    STAA    PIN
00000302 >9607                    LDAA    GROUP+7
00000304 >9701                    STAA    PIN+1

00000306 >7e0000                  JMP     OUT1

                          *****************************************************
                          *                                                   *
                          *       Process group 2A (RT).                      *
                          *       Group 2B not handled.                       *
                          *                                                   *
                          *****************************************************

00000309  8120            PROC2   CMPA    #$20                    GROUP 2A
0000030b  2634                    BNE     PROC4

0000030d >12031009        GRP2    BRSET   GROUP+3,$10,TEXTB
00000311 >1200020f        TEXTA   BRSET   STAT3,$02,NCH
00000315 >140002                  BSET    STAT3,$02
00000318  2007                    BRA     LCDINI
0000031a >13000206        TEXTB   BRCLR   STAT3,$02,NCH
0000031e >150002                  BCLR    STAT3,$02
00000321 >bd0000          LCDINI  JSR     INITR                   CLEAR RT

00000324 >d603            NCH     LDAB    GROUP+3                 GROUP 2A  -  RT
00000326  c40f                    ANDB    #$0F
00000328  58                      LSLB
00000329  58                      LSLB
0000032a >ce0000                  LDX     #RT
0000032d  3a                      ABX
0000032e >9604                    LDAA    GROUP+4
00000330  a705                    STAA    5,X
00000332 >9605                    LDAA    GROUP+5
00000334  a706                    STAA    6,X
00000336 >9606                    LDAA    GROUP+6
00000338  a707                    STAA    7,X
0000033a >9607                    LDAA    GROUP+7
0000033c  a708                    STAA    8,X
0000033e >7e0000                  JMP     OUT1
```

```
                               **************************************************
                               *                                                *
                               *       Process group 4A (CT).                   *
                               *                                                *
                               **************************************************

00000341  8140                 PROC4  CMPA   #$40             GROUP 4A  -  CT
00000343  2703                        BEQ    GRP4
00000345 >7e0000                      JMP    PROC14

00000348 >9603                 GRP4   LDAA   GROUP+3
0000034a  46                          RORA
0000034b  8401                        ANDA   #$01
0000034d >9700                        STAA   BMJD             MJD MS BIT
0000034f >9604                        LDAA   GROUP+4
00000351  46                          RORA
00000352 >9701                        STAA   BMJD+1           MJD MSD

00000354 >9606                        LDAA   GROUP+6          GROUP 4
00000356 >760005                      ROR    GROUP+5          3210xxxx 4
00000359  46                          RORA                    43210xxx x
0000035a  44                          LSRA                    -43210xx x
0000035b  44                          LSRA                    --43210x x
0000035c  44                          LSRA                    ---43210 x
0000035d >9700                        STAA   OUR

0000035f >9605                        LDAA   GROUP+5
00000361 >9702                        STAA   BMJD+2           MJD LSD

00000363 >9606                        LDAA   GROUP+6          xxxx5432 x
00000365 >780007                      LSL    GROUP+7          xxxx5432 1
00000368  49                          ROLA                    xxx54321 x
00000369 >780007                      LSL    GROUP+7          xxx54321 0
0000036c  49                          ROLA                    xx543210 x
0000036d  843f                        ANDA   #$3F             --543210 x
0000036f >9700                        STAA   MIN
00000371 >7f0000                      CLR    SEC
00000374 >7f0000                      CLR    TH8
00000377 >140040                      BSET   STAT3,$40        UPDATE MJD

                               **************************************************
                               *                                                *
                               *       Local time difference adjustment.        *
                               *                                                *
                               **************************************************

0000037a >d607                 LOCAL  LDAB   GROUP+7
0000037c  58                          LSLB
0000037d  2764                        BEQ    OUT1             ADJUSTMENT ?
0000037f  2436                        BCC    POS              YES, POSITIVE ?

00000381  54                   NEG    LSRB                    NO, NEGATIVE
00000382  54                          LSRB
00000383  54                          LSRB
00000384  54                          LSRB                    HOURS IN B
00000385  240d                        BCC    NOTHN            1/2 HOUR ?
00000387 >9600                        LDAA   MIN              YES
00000389  801e                        SUBA   #30              SUBTRACT 30 MINUTES
0000038b  2a05                        BPL    LT60             UNDERFLOW ?
0000038d  8b3c                        ADDA   #60              YES, ADD 60 MINUTES
0000038f >7a0000                      DEC    OUR              AND SUBTRACT 1 HOUR
00000392 >9700                 LT60   STAA   MIN

00000394 >d000                 NOTHN  SUBB   OUR              NEGATIVE HOUR OFFSET, MINUS UTC HOURS
00000396  53                          COMB                    WRONG WAY ROUND SO COMPLEMENT
00000397  4c                          INCA                    AND INCREMENT
00000398  2a19                        BPL    ZOM              UNDERFLOW ?
0000039a  cb18                        ADDB   #24              YES, ADD 24 HOURS
0000039c >d700                        STAB   OUR

0000039e >7d0002                      TST    BMJD+2           AND SUBTRACT A DAY
000003a1  260b                        BNE    TT2              LSB WILL UNDERFLOW ?
000003a3 >7d0001                      TST    BMJD+1           YES
000003a6  2603                        BNE    TT1              MSB WILL UNDERFLOW ?
000003a8 >7a0000                      DEC    BMJD             YES DECREMENT MS BIT
000003ab >7a0001               TT1    DEC    BMJD+1           DECREMENT MSB
000003ae >7a0002               TT2    DEC    BMJD+2           DECREMENT LSB
000003b1  2030                        BRA    OUT1

000003b3 >d700                 ZOM    STAB   OUR
000003b5  202c                        BRA    OUT1

000003b7  54                   POS    LSRB                    POSITIVE ADJUSTMENT
000003b8  54                          LSRB
000003b9  54                          LSRB
000003ba  54                          LSRB                    HOURS IN B
000003bb  240f                        BCC    NOTHP            HALF HOUR ?
000003bd  861e                        LDAA   #30              YES, ADD 30 MINUTES
000003bf >9b00                        ADDA   MIN
000003c1  813b                        CMPA   #59
000003c3  2305                        BLS    HDON             OVERFLOW ?
000003c5  803c                        SUBA   #60              YES, SUBTRACT 60 MINUTES
000003c7 >7c0000                      INC    OUR              AND ADD AN HOUR
000003ca >9700                 HDON   STAA   MIN

000003cc >db00                 NOTHP  ADDB   OUR              HOUR OFFSET, ADD UTC HOURS
000003ce  c117                        CMPB   #23
000003d0  230f                        BLS    ADDON            OVERFLOW ?
000003d2  c018                        SUBB   #24              YES, SUBTRACT 24 HOURS
000003d4 >7c0002                      INC    BMJD+2           AND ADD A DAY
000003d7  2608                        BNE    ADDON
000003d9 >7c0001                      INC    BMJD+1
000003dc  2603                        BNE    ADDON
000003de >7c0000                      INC    BMJD
000003e1 >d700                 ADDON  STAB   OUR
000003e3 >150002               OUT1   BCLR   STAT2,$02        GROUP HANDLED, CLEAR FLAG
000003e6  3b                          RTI
```

```
                     ************************************************
                     *                                              *
                     *       Process group 14 (EON).                *
                     *                                              *
                     ************************************************

000003e7  81e0       PROC14  CMPA   #SE0
000003e9  2703               BEQ    GRP14A
000003eb >7e0000             JMP    PR14B

000003ee >13031003   GRP14A  BRCLR  GROUP+3,$10,TPLO   TP(ON) HIGH ?
                     *       JMP    OUT2               NO, ENABLE TO COLLECT DATA ONLY WHEN TP=1
000003f2  01                 NOP
000003f3  01                 NOP
000003f4  01                 NOP
000003f5 >7f0000     TPLO    CLR    ITMP1
000003f8 >d600       LPIL    LDAB   ITMP1
000003fa >ce0000             LDX    #EON
000003fd  3a                 ABX
000003fe  a600               LDAA   0,X
00000400 >9106               CMPA   GROUP+6
00000402  2663               BNE    NOTH               PI MATCH (MSB) ?
00000404  a601               LDAA   1,X
00000406 >9107               CMPA   GROUP+7
00000408  265d               BNE    NOTH               PI MATCH (LSB) ?

                     *       LDAA   GROUP+3            TP (ON)
                     *       ANDA   #S10
                     *       STAA   SB,X

0000040a >d603               LDAB   GROUP+3
0000040c  c40f               ANDB   #S0F
0000040e  c104               CMPB   #4                 PS ?
00000410  2411               BHS    NPS
00000412  58                 LSLB                      YES
00000413 >db00               ADDB   ITMP1
00000415 >ce0000             LDX    #EON
00000418  3a                 ABX
00000419 >9604               LDAA   GROUP+4
0000041b  a702               STAA   2,X
0000041d >9605               LDAA   GROUP+5
0000041f  a703               STAA   3,X
00000421  20c0               BRA    OUT1

00000423  c104       NPS     CMPB   #4                 AF ?
00000425  262c               BNE    TRYPIN             TRYPTY

00000427 >9604               LDAA   GROUP+4            YES, METHOD A

00000429  81fa               CMPA   #250
0000042b  2616               BNE    NMLW               MEDIUM OR LONG WAVE ?
0000042d  a60c               LDAA   SC,X               YES
0000042f  81ff               CMPA   #SFF               FIRST 2 BYTES ALREADY IN ?
00000431  2777               BEQ    OUT2               IF NOT, DO NOTHING
00000433  a60e               LDAA   SE,X               YES
00000435  81ff               CMPA   #SFF               M/L FREQUENCY ALREADY IN ?
00000437  2671               BNE    OUT2               IF SO, DO NOTHING
00000439  86fa               LDAA   #250               NO, STORE FIRST FREQUENCY AFTER
0000043b  a70e               STAA   SE,X               ARRIVAL OF INITIAL BYTES
0000043d >9605               LDAA   GROUP+5
0000043f  a70f               STAA   SF,X
00000441  2067               BRA    OUT2

00000443  81e0       NMLW    CMPA   #224
00000445  250a               BLO    TOOLS
00000447  81f9               CMPA   #249
00000449  2206               BHI    TOOLS
0000044b  a70c               STAA   SC,X
0000044d >9605               LDAA   GROUP+5
0000044f  a70d               STAA   SD,X
00000451  2057       TOOLS   BRA    OUT2

                     *TRYPTY CMPB   #S0D
                     *       BNE    TRYPIN
                     *       LDAA   GROUP+4            PTY
                     *       LSRA
                     *       LSRA
                     *       LSRA
                     *       LDAB   ITMP1
                     *       LDX    #EON
                     *       ABX
                     *       STAA   SA,X
                     *       BRA    OUT2

00000453  c10e       TRYPIN  CMPB   #S0E
00000455  2653               BNE    OUT2
00000457 >d600               LDAB   ITMP1              PIN
00000459 >ce0000             LDX    #EON
0000045c  3a                 ABX
0000045d >9604               LDAA   GROUP+4
0000045f  a70a               STAA   SA,X
00000461 >9605               LDAA   GROUP+5
00000463  a70b               STAA   SB,X
00000465  2043               BRA    OUT2

00000467  81ff       NOTH    CMPA   #SFF               END OF PI LIST ?
00000469  260a               BNE    NOTH1
0000046b >9606               LDAA   GROUP+6            YES, ADD THIS PI CODE
0000046d  a700               STAA   0,X
0000046f >9607               LDAA   GROUP+7            TO EON TABLE
00000471  a701               STAA   1,X
00000473  2035               BRA    OUT2

00000475 >9600       NOTH1   LDAA   ITMP1              NOT END, TRY NEXT ENTRY
00000477  8b10               ADDA   #16
00000479 >9700               STAA   ITMP1
0000047b  272d               BEQ    OUT2
0000047d >7e0000             JMP    LPIL

00000480  81e8       PR14B   CMPA   #SE8               GROUP 14B
00000482  2626               BNE    OUT2
```

```
                              *************************************************
                              *                                               *
                              *       Process group 14B (switch to TA).       *
                              *                                               *
                              *************************************************

00000484 >9600                GRP14B  LDAA   STAT3
00000486  840c                        ANDA   #$0C
00000488  8104                        CMPA   #$04                   EON ? (TA=1, TP=0)
0000048a  261e                        BNE    OUT2
0000048c  181e082019                  BRSET  PORTD,Y,$20,OUT2       STANDBY ?
00000491 >13030815                    BRCLR  GROUP+3,$08,OUT2       EON, TA (ON) HIGH ?
00000495 >13031011                    BRCLR  GROUP+3,$10,OUT2       EON, TP (ON) HIGH ?
00000499 >dc06                TAOH    LDD    GROUP+6
0000049b >dd00                        STD    PION                   SAVE PI (ON)
0000049d >12000406                    BRSET  STAT4,$04,OUT3         TP SWITCHING ENABLED ?
000004a1  8601                        LDAA   #1                     SETUP REASON FOR NO TP
000004a3 >9700                        STAA   REARET
000004a5  2003                        BRA    OUT2
000004a7 >140080              OUT3    BSET   STAT4,$80              YES, SET FLAG
000004aa >150002              OUT2    BCLR   STAT2,$02              GROUP HANDLED, CLEAR FLAG
000004ad  3b                          RTI

                              *************************************************
                              *                                               *
                              *       Update PTY display mode.                *
                              *                                               *
                              *************************************************

000004ae >d600                PTYD    LDAB   PTY                    PTY
000004b0  c110                        CMPB   #16
000004b2  2501                        BLO    BOK
000004b4  5f                          CLRB
000004b5  8610                BOK     LDAA   #16
000004b7  3d                          MUL
000004b8 >ce0000                      LDX    #PTYT
000004bb  3a                          ABX
000004bc >18ce0000                    LDY    #DISP
000004c0  a600                LCD3    LDAA   0,X
000004c2  18a700                      STAA   0,Y
000004c5  1808                        INY
000004c7  08                          INX
000004c8 >188c0010                    CPY    #DISP+16
000004cc  25f2                        BLO    LCD3
000004ce  39                          RTS`

                              ****************************************************
                              *                                                  *
                              *       Extract MJD and convert to decimal.        *
                              *                                                  *
                              ****************************************************

000004cf >9602                MJDAT   LDAA   BMJD+2
000004d1 >9702                        STAA   YR+2
000004d3 >9601                        LDAA   BMJD+1
000004d5 >9701                        STAA   YR+1
000004d7 >9600                        LDAA   BMJD
000004d9 >9700                        STAA   YR
000004db >ce0000                      LDX    #R                     CLEAR
000004de >df00                        STX    NUM1
000004e0 >bd0000                      JSR    CLRAS                  R
000004e3 >7c0008                      INC    R+ND-1                 R <- 1
000004e6 >ce0000                      LDX    #MJD
000004e9 >bd0000                      JSR    CLRAS                  CLEAR MJD
000004ec  8611                        LDAA   #17                    17 BITS TO CONVERT
000004ee >9700                        STAA   W6
000004f0 >740000              LOOPJ   LSR    YR                     MOVE OUT
000004f3 >760001                      ROR    YR+1
000004f6 >760002                      ROR    YR+2                   FIRST (LS) BIT
000004f9  2408                        BCC    NXTJ                   ZERO ?
000004fb >ce0000                      LDX    #MJD                   ONE, ADD
000004fe >df00                        STX    NUM2                   CURRENT VALUE
00000500 >bd0000                      JSR    ADD                    OF R
00000503 >ce0000              NXTJ    LDX    #R                     ADD R
00000506 >df00                        STX    NUM2                   TO
00000508 >bd0000                      JSR    ADD                    ITSELF
0000050b >7a0000                      DEC    W6                     ALL
0000050e  26e0                        BNE    LOOPJ                  DONE ?
00000510 >150040                      BCLR   STAT3,$40              MJD UPDATED
00000513 >7e0000                      JMP    MJDC                   CONVERT MJD TO DAY, DATE. MONTH & YEAR

                              *************************************************
                              *                                               *
                              *       Bytes for /16 LCD modules.              *
                              *                                               *
                              *************************************************

00000516 >bd0000              LCD401  JSR    WAIT
00000519  86a8                        LDAA   #$A8                   ADDRESS 40
0000051b >bd0000                      JSR    CLOCK                  SEND IT TO MODULE
0000051e >ce0000                      LDX    #DISP
00000521 >bd0000              LCD41   JSR    WAIT
00000524  181c0420                    BSET   PORTB,Y,$20            WRITE DATA
00000528  a608                        LDAA   8,X                    GET A BYTE
0000052a  81ff                        CMPA   #$FF
0000052c  2602                        BNE    COK2
0000052e  862d                        LDAA   #$2D
00000530 >bd0000              COK2    JSR    CLOCK                  SEND IT TO MODULE
00000533  08                          INX
00000534 >8c0008                      CPX    #DISP+8                DONE ?
00000537  26e8                        BNE    LCD41
00000539  39                          RTS
```

```
                            ****************************************************
                            *                                                  *
                            *       Display type selection.                    *
                            *                                                  *
                            ****************************************************

0000053a >13001006          MOD     BRCLR   STAT2,$10,NOCL
0000053e >bd0000                    JSR     INITD                   CLEAR PIN, DI, M/S, PTY & RT
00000541 >150010                    BCLR    STAT2,$10               PERHARS EVEN PS
00000544  181f08200d        NOCL    BRCLR   PORTD,Y,$20,TRYRT       STANDBY ?
00000549 >1200046e                  BRSET   STAT5,$04,SLPD          YES, SLEEP DISPLAY ?
0000054d >1200087c                  BRSET   STAT4,$08,ALRMJ         NO, ALARM DISPLAY ?
00000551 >bd0000                    JSR     STBYD                   NO, NORMAL STANDBY DISPLAY
00000554  207a                      BRA     ROW1
00000556 >13000258          TRYRT   BRCLR   STAT5,$02,RTTTS         RDS DISPLAY ?
0000055a >9600                      LDAA    RTDIS
0000055c  8101                      CMPA    #1
0000055e  2605                      BNE     NPTY
00000560 >bd0000                    JSR     PTYD                    PTY DISPLAY
00000563  206b                      BRA     ROW1
00000565  8102              NPTY    CMPA    #2
00000567  2605                      BNE     NPI
00000569 >bd0000                    JSR     DIP1                    PI
0000056c  2062                      BRA     ROW1
0000056e  8103              NPI     CMPA    #3
00000570  2605                      BNE     NTAP
00000572 >bd0000                    JSR     DITAP                   TA & PT
00000575  2059                      BRA     ROW1
00000577  8104              NTAP    CMPA    #4
00000579  2605                      BNE     NPIN1
0000057b >bd0000                    JSR     DPIN1                   PIN - HEX
0000057e  2050                      BRA     ROW1
00000580  8105              NPIN1   CMPA    #5
00000582  2605                      BNE     NPIN2
00000584 >bd0000                    JSR     DPIN2                   PIN - DAY AND TIME
00000587  2047                      BRA     ROW1
00000589  8106              NPIN2   CMPA    #6
0000058b  2605                      BNE     NMJD
0000058d >bd0000                    JSR     DMJD                    MJD
00000590  203e                      BRA     ROW1
00000592  8107              NMJD    CMPA    #7
00000594  2605                      BNE     NMSD
00000596 >bd0000                    JSR     DMSD                    M/S & DI
00000599  2035                      BRA     ROW1
0000059b  8108              NMSD    CMPA    #8
0000059d  2605                      BNE     NONPI
0000059f >bd0000                    JSR     DONPI                   LAST TA PI
000005a2  202c                      BRA     ROW1
000005a4  8109              NONPI   CMPA    #9
000005a6  2605                      BNE     NRET
000005a8 >bd0000                    JSR     DRET                    TA RETURN
000005ab  2023                      BRA     ROW1
000005ad >bd0000            NRET    JSR     DEON
000005b0  201e                      BRA     ROW1

                            ****************************************************
                            *                                                  *
                            *       Display type selection (cont.).            *
                            *                                                  *
                            ****************************************************

000005b2 >13000405          RTTTS   BRCLR   STAT2,$04,SLPD          RT DISPLAY ?
000005b6 >bd0000                    JSR     RTDSP
000005b9  2015                      BRA     ROW1
000005bb >13000405          SLPD    BRCLR   STAT5,$04,NRMD          SLEEP TIMER DISPLAY ?
000005bf >bd0000                    JSR     SLEEPD
000005c2  200c                      BRA     ROW1
000005c4 >12000805          NRMD    BRSET   STAT4,$08,ALRMJ         ALARM DISPLAY ?
000005c8 >bd0000                    JSR     NORMD
000005cb  2003                      BRA     ROW1
000005cd >bd0000            ALRMJ   JSR     ALRMD

000005d0 >ce0000            ROW1    LDX     #DISP
000005d3  a600              CLOP2   LDAA    0,X
000005d5  a110                      CMPA    16,X                    HAS CHARACTER CHANGED ?
000005d7  2607                      BNE     DIFF
000005d9  08                        INX                             NO, NEXT
000005da >8c0010                    CPX     #DISP+16                LAST ?
000005dd  26f4                      BNE     CLOP2
000005df  39                        RTS                             YES, NO NEED TO UPDATE DISPLAYS

000005e0  18ce1000          DIFF    LDY     #$1000
000005e4  181f0a8049                BRCLR   PORTE,Y,$80,VFD         LCD OR VFD ?
000005e9 >bd0000                    JSR     WAIT                    LCD
000005ec  860c                      LDAA    #$0C                    SWITCH DISPLAY ON
000005ee >bd0000                    JSR     CLOCK                   LATCH IT
000005f1 >bd0000                    JSR     WAIT
000005f4  8630                      LDAA    #$30                    /8  DISPLAY
000005f6  181f008002                BRCLR   PORTA,Y,$80.M8A
000005fb  8638                      LDAA    #$38                    /16 DISPLAY
000005fd >bd0000            M8A     JSR     CLOCK                   LATCH IT
00000600 >bd0000                    JSR     WAIT
00000603  8680                      LDAA    #$80                    ADDRESS DISPLAY RAM
00000605 >bd0000                    JSR     CLOCK                   LATCH IT

00000608 >ce0000                    LDX     #DISP
0000060b  18ce1000                  LDY     #$1000
0000060f >bd0000            LCD     JSR     WAIT
00000612  181c0420                  BSET    PORTB,Y,$20             WRITE DATA
00000616  a600                      LDAA    0,X                     GET A BYTE
00000618  a710                      STAA    16,X                    SAVE IT IN "CURRENT" BUFFER
0000061a  81ff                      CMPA    #$FF
0000061c  2602                      BNE     COK
0000061e  862d                      LDAA    #$2D
00000620 >bd0000            COK     JSR     CLOCK                   SEND IT TO MODULE
00000623  08                        INX
00000624 >8c0010                    CPX     #DISP+16                DONE ?
00000627  26e6                      BNE     LCD
00000629  181f008003                BRCLR   PORTA,Y,$80,MUX8
0000062e >bd0000                    JSR     LCD401
00000631  39                MUX8    RTS
```

```
                            **************************************************
                            *                                                *
                            *       VFD.                                     *
                            *                                                *
                            **************************************************

00000632  18ce1000          VFD     LDY    #$1000
00000636  181d0402                  BCLR   PORTB,Y,$02      DATA LOW ?
0000063a  181c0401                  BSET   PORTB,Y,$01      CLOCK HIGH ?
0000063e  181d0404                  BCLR   PORTB,Y,$04      ENABLE LOW

00000642 >ce0000                    LDX    #INITF           SEND VFD SET-UP BYTES
00000645  a600              DIS5    LDAA   0,X
00000647 >df00                      STX    W7               SAVE INDEX
00000649  8d2c                      BSR    VFDL
0000064b >8c0007                    CPX    #INITF+7
0000064e  26f5                      BNE    DIS5             LAST BYTE ?

00000650 >ce0000                    LDX    #DISP            SEND 16 CHARACTER BYTES
00000653 >df00              VFD3    STX    W7               SAVE INDEX
00000655  e600                      LDAB   0,X              ASCII
00000657  e710                      STAB   16,X             SAVE IT IN "CURRENT" BUFFER
00000659  c1ff                      CMPB   #$FF
0000065b  2602                      BNE    NOTFF
0000065d  c62d                      LDAB   #$2D             "-"
0000065f  c47f              NOTFF   ANDB   #$7F             IGNORE BIT 7
00000661 >ce0000                    LDX    #VTAB
00000664  3a                        ABX
00000665  a600                      LDAA   0,X              CONVERT TO VFD CHARACTER SET
00000667  8d0e                      BSR    VFDL
00000669 >8c0010                    CPX    #DISP+16
0000066c  26e5                      BNE    VFD3             LAST BYTE ?

0000066e  181c0404                  BSET   PORTB,Y,$04      ENABLE HIGH
00000672  181d0401                  BCLR   PORTB,Y,$01      CLOCK LOW ?
00000676  39                        RTS

00000677  c608              VFDL    LDAB   #8
00000679  44                DIS3    LSRA                    GET A BIT
0000067a  2404                      BCC    DIS4
0000067c  181c0402                  BSET   PORTB,Y,$02      DATA HIGH
00000680  181d0401          DIS4    BCLR   PORTB,Y,$01      CLOCK
00000684  181c0401                  BSET   PORTB,Y,$01      IT
00000688  181d0402                  BCLR   PORTB,Y,$02      CLEAR DATA
0000068c  5a                        DECB                    COMPLETE ?
0000068d  26ea                      BNE    DIS3             NO
0000068f  c654                      LDAB   #84
00000691  5a                DEL     DECB                    WAIT 200uS
00000692  26fd                      BNE    DEL
00000694 >de00                      LDX    W7               RESTORE INDEX
00000696  08                        INX
00000697  39                        RTS

00000698  a00fb000800090    INITF   FCB    $A0,$0F,$B0,$00,$80,$00,$90


                            **************************************************
                            *                                                *
                            *       Normal display (PS and time or freq).    *
                            *                                                *
                            **************************************************

0000069f  8620              NORMD   LDAA   #$20
000006a1 >b70001                    STAA   DISP+1
000006a4 >b7000a                    STAA   DISP+10
000006a7  862e                      LDAA   #$2E             .
000006a9 >13000203                  BRCLR  STAT4,$02,NOTP   DP TO INDICATE SLEEP TIMER RUNNING ?
                            *       BRCLR  TH8,$04,NOTP     FLASH IT
000006ad >b70001                    STAA   DISP+1
000006b0 >12000403          NOTP    BRSET  STAT4,$04,TYP1   DP TO INDICATE TRAFFIC SWITCH DISABLED ?
000006b4 >b7000a                    STAA   DISP+10

000006b7 >13004047          TYP1    BRCLR  STAT2,$40,TYP2   CLEAR PS NAME ?
000006bb >150040                    BCLR   STAT2,$40        YES, CLEAR FLAG
000006be  86ff                      LDAA   #$FF             AND PS NAME
000006c0 >18ce0000                  LDY    #PSN
000006c4  18a700            CPS     STAA   0,Y
000006c7  1808                      INY
000006c9 >188c0007                  CPY    #PSN+7
000006cd  23f5                      BLS    CPS
000006cf >1300012f                  BRCLR  STAT,$01,TYP2    FREQUENCY MODE ?
000006d3 >d601                      LDAB   RQ+1             NO, DISPLAY FREQUENCY AS PS NAME
000006d5  2602                      BNE    NZ1B
000006d7  c6f0                      LDAB   #$F0
000006d9  cb30              NZ1B    ADDB   #$30
000006db >f70003                    STAB   PSN+3
000006de >9602                      LDAA   RQ+2
000006e0  2606                      BNE    NZ2B
000006e2  c120                      CMPB   #$20
000006e4  2602                      BNE    NZ2B
000006e6  86f0                      LDAA   #$F0
000006e8  8b30              NZ2B    ADDA   #$30
000006ea >b70004                    STAA   PSN+4
000006ed >9603                      LDAA   RQ+3
000006ef  8b30                      ADDA   #$30
000006f1 >b70005                    STAA   PSN+5
000006f4 >9604                      LDAA   RQ+4
000006f6  8b30                      ADDA   #$30
000006f8 >b70006                    STAA   PSN+6
000006fb >9605                      LDAA   RQ+5
000006fd  8b30                      ADDA   #$30
000006ff >b70007                    STAA   PSN+7

00000702 >18ce0000          TYP2    LDY    #PSN
00000706 >ce0000                    LDX    #DISP
00000709  18a600            MPS     LDAA   0,Y              GET PS NAME
0000070c  a702                      STAA   2,X              AND PUT INTO DISPLAY RAM
0000070e  08                SONG    INX
0000070f  1808                      INY
00000711 >188c0007                  CPY    #PSN+7
00000715  23f2                      BLS    MPS
00000717 >9600                      LDAA   LED              GET PROGRAM NUMBER
00000719  8b30                      ADDA   #$30
0000071b >b70000                    STAA   DISP
0000071e >13004009                  BRCLR  STAT5,$40,NTSCN2 STORE MODE ?
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00000722 >13000405                BRCLR  TH8,$04,NTSCN2     YES, FLASH ?
00000726  8620                    LDAA   #$20               YES
00000728 >b70000                  STAA   DISP

0000072b >d600           NTSCN2   LDAB   PSNP
0000072d  2718                    BEQ    CJ                 EDITING ?
0000072f >13000702                BRCLR  TH8,$07,NCJ        YES, FLASH
00000733  2012                    BRA    CJ
00000735 >ce0001         NCJ      LDX    #DISP+1
00000738  3a                      ABX
00000739  a600                    LDAA   0,X                GET CHARACTER TO FLASH
0000073b  8120                    CMPA   #$20               SPACE ?
0000073d  2704                    BEQ    SPCE
0000073f  8620                    LDAA   #$20               NO, REPLACE WITH SPACE
00000741  2002                    BRA    CJP
00000743  862d           SPCE     LDAA   #$2D               YES, REPLACE WITH -
00000745  a700           CJP      STAA   0,X

00000747 >12008007       CJ       BRSET  STAT2,$80,TYPE3    TA SWITCH ?
0000074b >13000103                BRCLR  STAT,$01,TYPE3     NO, FREQUENCY MODE ?
0000074f >7e0000                  JMP    PRGMD              NO, DISPLAY TIME
00000752  18ce1000       TYPE3    LDY    #$1000
00000756  181e000251              BRSET  PORTA,Y,$02,AMD    YES DISPLAY FREQUENCY, AM BAND ?
0000075b >d601           FMD      LDAB   RQ+1               NO, FM
0000075d  2602                    BNE    NZ1
0000075f  c6f0                    LDAB   #$F0
00000761  cb30           NZ1      ADDB   #$30
00000763 >f7000a                  STAB   DISP+10
00000766 >9602                    LDAA   RQ+2
00000768  2606                    BNE    NZ2
0000076a  c120                    CMPB   #$20
0000076c  2602                    BNE    NZ2
0000076e  86f0                    LDAA   #$F0
00000770  8b30           NZ2      ADDA   #$30
00000772 >b7000b                  STAA   DISP+11
00000775 >9603                    LDAA   RQ+3
00000777  8b30                    ADDA   #$30
00000779 >b7000c                  STAA   DISP+12
0000077c  862e                    LDAA   #$2E
0000077e >12000206                BRSET  STAT5,$02,SKCL     RDS (EON) DISPLAY ?
00000782 >13002002                BRCLR  STAT5,$20,SKCL
00000786  862d                    LDAA   #$2D
00000788 >b7000d         SKCL     STAA   DISP+13
0000078b >9604                    LDAA   RQ+4
0000078d  8b30                    ADDA   #$30
0000078f >b7000e                  STAA   DISP+14
00000792 >9605                    LDAA   RQ+5
00000794  8b30                    ADDA   #$30
00000796 >1200020e                BRSET  STAT5,$02,SKCL2    RDS (EON) DISPLAY ?
0000079a >1200200a                BRSET  STAT5,$20,SKCL2    NO, INHIBITED ?
0000079e >13000806                BRCLR  STAT3,$08,SKCL2    NO, TP FLAG SET ?
000007a2 >13000402                BRCLR  TH8,$04,SKCL2      YES, FLASH ?
000007a6  862e                    LDAA   #$2E
000007a8 >b7000f         SKCL2    STAA   DISP+15
000007ab  39                      RTS

                         ***************************************************
                         *                                                 *
                         *        Normal display (cont.).                  *
                         *                                                 *
                         ***************************************************

000007ac  c620           AMD      LDAB   #$20               YES, AM
000007ae >f7000a                  STAB   DISP+10
000007b1 >d601                    LDAB   RQ+1
000007b3  2602                    BNE    NZ1A
000007b5  c6f0                    LDAB   #$F0
000007b7  cb30           NZ1A     ADDB   #$30
000007b9 >f7000b                  STAB   DISP+11
000007bc >9602                    LDAA   RQ+2
000007be  2606                    BNE    NZ2A
000007c0  c120                    CMPB   #$20
000007c2  2602                    BNE    NZ2A
000007c4  86f0                    LDAA   #$F0
000007c6  8b30           NZ2A     ADDA   #$30
000007c8 >b7000c                  STAA   DISP+12
000007cb >9603                    LDAA   RQ+3
000007cd  8b30                    ADDA   #$30
000007cf >b7000d                  STAA   DISP+13
000007d2 >9604                    LDAA   RQ+4
000007d4  8b30                    ADDA   #$30
000007d6 >b7000e                  STAA   DISP+14
000007d9 >9605                    LDAA   RQ+5
000007db  8b30                    ADDA   #$30
000007dd >b7000f                  STAA   DISP+15
000007e0  39                      RTS

000007e1 >9600           PRGMD    LDAA   OUR                GET TIME
000007e3 >bd0000                  JSR    CBCD
000007e6  8130                    CMPA   #$30               LEADING ZERO ?
000007e8  2602                    BNE    TNZ
000007ea  8620                    LDAA   #$20               YES, MAKE IT A SPACE
000007ec >fd000b         TNZ      STD    DISP+11
000007ef >9600           CMIN     LDAA   MIN
000007f1 >bd0000                  JSR    CBCD
000007f4 >fd000e                  STD    DISP+14
000007f7  863a           CSEC     LDAA   #$3A
000007f9 >12002006                BRSET  STAT6,$20,DDC      FLASHING ENABLED ?
000007fd >13000402                BRCLR  TH8,$04,DDC        YES, TIME TO FLASH ?
00000801  8620                    LDAA   #$20               YES, 0.5 Hz FLASHING COLON
00000803 >b7000d         DDC      STAA   DISP+13
00000806  39                      RTS
```

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                        ******************************************************
                        *                                                    *
                        *       RT display mode.                             *
                        *                                                    *
                        *       Last TA PI display.                          *
                        *                                                    *
                        ******************************************************

00000807 >9600          RTDSP    LDAA    DISP2
00000809  261b                   BNE     SKP1
0000080b >7e0000                 JMP     PTYD
0000080e >d600          NXT      LDAB    DISP2
00000810 >ceffff                 LDX     #RT-1
00000813  3a                     ABX
00000814  a600                   LDAA    0,X                  RT
00000816  8120                   CMPA    #$20
00000818  2617                   BNE     NOTSP                SPACE ?
0000081a >1300200e               BRCLR   STAT2,$20,FSP        YES, FIRST ONE ?
0000081e >7c0000                 INC     DISP1                NO, SKIP THIS ONE
00000821 >7c0000                 INC     DISP2
00000824 >9600                   LDAA    DISP2
00000826  8145          SKP1     CMPA    #69
00000828  221e                   BHI     LCD4                 END OF RT BUFFER
0000082a  20e2                   BRA     NXT                  NO, GET NEXT CHARACTER
0000082c >140020        FSP      BSET    STAT2,$20            FIRST SPACE, SET FLAG
0000082f  2003                   BRA     CONT
00000831 >150020        NOTSP    BCLR    STAT2,$20            NOT A SPACE, CLEAR FLAG
00000834 >9700          CONT     STAA    W7                   SAVE NEW CHARACTER
00000836 >ce0000                 LDX     #DISP
00000839  a601          ILP1     LDAA    1,X                  MOVE
0000083b  a700                   STAA    0,X                  REST
0000083d  08                     INX                          LEFT
0000083e >8c000f                 CPX     #DISP+15             ONE
00000841  26f6                   BNE     ILP1                 PLACE
00000843 >9600                   LDAA    W7
00000845 >b7000f                 STAA    DISP+15              ADD NEW CHAR.
00000848  39            LCD4     RTS

00000849 >ce0000        DONPI    LDX     #ONPIST
0000084c >18ce0000               LDY     #DISP
00000850  a600          DLOPO    LDAA    0,X
00000852  18a700                 STAA    0,Y
00000855  08                     INX
00000856  1808                   INY
00000858 >8c000f                 CPX     #ONPIST+15
0000085b  23f3                   BLS     DLOPO
0000085d >9600                   LDAA    PION
0000085f  270e                   BEQ     PINVO
00000861 >bd0000                 JSR     SPLIT
00000864 >fd000b                 STD     DISP+11
00000867 >9601                   LDAA    PION+1
00000869 >bd0000                 JSR     SPLIT
0000086c >fd000d                 STD     DISP+13
0000086f  39            PINVO    RTS

                        ******************************************************
                        *                                                    *
                        *       Standby display.                             *
                        *                                                    *
                        ******************************************************

00000870 >12001058      STBYD    BRSET   STAT4,$10,ALRMA      ALARM ARMED ?
00000874 >d600          NOTODAY  LDAB    DOW                  NO, GET DAY OF WEEK
00000876  58                     LSLB
00000877 >db00                   ADDB    DOW
00000879 >ce0000                 LDX     #DNAME
0000087c  3a                     ABX
0000087d  a600                   LDAA    0,X
0000087f >b70000                 STAA    DISP
00000882  a601                   LDAA    1,X
00000884 >b70001                 STAA    DISP+1
00000887  a602                   LDAA    2,X
00000889 >b70002                 STAA    DISP+2
0000088c  8620                   LDAA    #$20
0000088e >b70003                 STAA    DISP+3
00000891 >b70006                 STAA    DISP+6
00000894 >b7000a                 STAA    DISP+10
00000897 >9601                   LDAA    DOM+1                DATE
00000899  8b30                   ADDA    #$30
0000089b >b70005                 STAA    DISP+5
0000089e >9600                   LDAA    DOM
000008a0  2702                   BEQ     ADD20                IF ZERO USE A SPACE
000008a2  8b10                   ADDA    #$10                 IF NOT MAKE ASCII
000008a4  8b20          ADD20    ADDA    #$20
000008a6 >b70004                 STAA    DISP+4
000008a9 >d601                   LDAB    MNTH+1               MONTH, LSD
000008ab >9600                   LDAA    MNTH                 MONTH, MSD
000008ad  2702                   BEQ     MTHZ
000008af  cb0a                   ADDB    #10
000008b1 >d700          MTHZ     STAB    W7
000008b3  58                     LSLB
000008b4 >db00                   ADDB    W7
000008b6 >ceffd                  LDX     #MNAME-3
000008b9  3a                     ABX
000008ba  a600                   LDAA    0,X
000008bc >b70007                 STAA    DISP+7
000008bf  a601                   LDAA    1,X
000008c1 >b70008                 STAA    DISP+8
000008c4  a602                   LDAA    2,X
000008c6 >b70009                 STAA    DISP+9
000008c9 >7e0000                 JMP     PRGMD
```

```
                               ************************************************
                               *                                              *
                               *       Standby (alarm armed) & PI displays.   *
                               *                                              *
                               ************************************************

000008cc >13008006             ALRMA   BRCLR   STAT5,$80,D7         ARMED, BUT IS IT 5-DAY ?
000008d0 >9600                         LDAA    DOW                  YES
000008d2  8104                         CMPA    #4                   SAT OR SUN ?
000008d4  229e                         BHI     NOTODAY              IF SO, THEN NORMAL STANDBY DISPLAY
000008d6 >9600                 D7      LDAA    AOUR                 GET ALARM HOURS
000008d8 >bd0000                       JSR     CBCD
000008db >fd0000                       STD     DISP
000008de >9600                         LDAA    AMIN
000008e0 >bd0000                       JSR     CBCD
000008e3 >fd0002                       STD     DISP+2
000008e6 >ce0000                       LDX     #ALARMF
000008e9 >18ce0000                     LDY     #DISP
000008ed  a601                 ALOP2   LDAA    1,X
000008ef  18a704                       STAA    4,Y
000008f2  08                           INX
000008f3  1808                         INY
000008f5 >8c0006                       CPX     #ALARMF+6
000008f8  23f3                         BLS     ALOP2
000008fa >7e0000                       JMP     PRGMD

                               ************************************************
                               *                                              *
                               *       PI display.                            *
                               *                                              *
                               ************************************************

000008fd >ce0000               DIPI    LDX     #PIST
00000900 >18ce0000                     LDY     #DISP
00000904  a600                 DLOP    LDAA    0,X
00000906  18a700                       STAA    0,Y
00000909  08                           INX
0000090a  1808                         INY
0000090c >8c000f                       CPX     #PIST+15
0000090f  23f3                         BLS     DLOP
00000911 >9600                         LDAA    PI
00000913  270e                         BEQ     PINV
00000915 >bd0000                       JSR     SPLIT
00000918 >fd000b                       STD     DISP+11
0000091b >9601                         LDAA    PI+1
0000091d >bd0000                       JSR     SPLIT
00000920 >fd000d                       STD     DISP+13
00000923  39                   PINV    RTS

                               ************************************************
                               *                                              *
                               *       Alarm display.                         *
                               *                                              *
                               ************************************************

00000924 >ce0000               ALRMD   LDX     #ALARMF
00000927 >13001003                     BRCLR   STAT4,$10,ALOFD      ARMED ?
0000092b >ce0000                       LDX     #ALARMN              YES
0000092e >18ce0000             ALOFD   LDY     #DISP                NO
00000932  a600                 ALOP    LDAA    0,X
00000934  18a700                       STAA    0,Y
00000937  08                           INX
00000938  1808                         INY
0000093a >188c000f                     CPY     #DISP+15
0000093e  23f2                         BLS     ALOP
00000940 >13001037                     BRCLR   STAT4,$10,ALOF       ALARM ARMED ?
00000944 >13008005                     BRCLR   STAT5,$80,NSD        YES, WEEKDAY ONLY ?
00000948  8635                         LDAA    #$35                 TES, REPLACE 7 WITH 5
0000094a >b70000                       STAA    DISP
0000094d >9600                 NSD     LDAA    AOUR                 GET ALARM HOURS
0000094f >bd0000                       JSR     CBCD
00000952 >fd000c                       STD     DISP+12
00000955 >9600                         LDAA    AMIN
00000957 >bd0000                       JSR     CBCD
0000095a >fd000e                       STD     DISP+14
0000095d >1300201a                     BRCLR   STAT4,$20,ALOF       SET-UP ?
00000961 >13000702                     BRCLR   THB,$07,NALOF
00000965  2014                         BRA     ALOF
00000967  8620                 NALOF   LDAA    #$20
00000969 >12004008                     BRSET   STAT4,$40,FH         HOURS ?
0000096d >b7000e                       STAA    DISP+14              NO, FLASH MINUTES
00000970 >b7000f                       STAA    DISP+15
00000973  2006                         BRA     ALOF
00000975 >b7000c               FH      STAA    DISP+12              YES, FLASH HOURS
00000978 >b7000d                       STAA    DISP+13
0000097b  39                   ALOF    RTS

                               ************************************************
                               *                                              *
                               *       TA/TP display.                         *
                               *                                              *
                               ************************************************

0000097c >ce0000               DITAP   LDX     #TAPST
0000097f >18ce0000                     LDY     #DISP
00000983  a600                 BLOP    LDAA    0,X
00000985  18a700                       STAA    0,Y
00000988  08                           INX
00000989  1808                         INY
0000098b >8c000f                       CPX     #TAPST+15
0000098e  23f3                         BLS     BLOP
00000990  8631                         LDAA    #$31
00000992 >13000803                     BRCLR   STAT3,$08,TPLOW
00000996 >b70006                       STAA    DISP+6
00000999 >13000403             TPLOW   BRCLR   STAT3,$04.TALOW
0000099d >b7000e                       STAA    DISP+14
000009a0  39                   TALOW   RTS
```

```
                                   ***************************************************
                                   *                                                 *
                                   *       PIN displays.                             *
                                   *                                                 *
                                   ***************************************************

000009a1 >ce0000                   DPIN1   LDX     #PINST1
000009a4 >18ce0000                         LDY     #DISP
000009a8  a600                     PLOP    LDAA    0,X
000009aa  18a700                           STAA    0,Y
000009ad  08                               INX
000009ae  1808                             INY
000009b0 >188c000f                         CPY     #DISP+15
000009b4  23f2                             BLS     PLOP
000009b6 >9600                             LDAA    PIN
000009b8  270e                             BEQ     PINNV
000009ba >bd0000                           JSR     SPLIT
000009bd >fd000b                           STD     DISP+11
000009c0 >9601                             LDAA    PIN+1
000009c2 >bd0000                           JSR     SPLIT
000009c5 >fd000d                           STD     DISP+13
000009c8  39                       PINNV   RTS

000009c9 >ce0000                   DPIN2   LDX     #PINST2
000009cc >18ce0000                         LDY     #DISP
000009d0  a600                     PLOP2   LDAA    0,X
000009d2  18a700                           STAA    0,Y
000009d5  08                               INX
000009d6  1808                             INY
000009d8 >188c000f                         CPY     #DISP+15
000009dc  23f2                             BLS     PLOP2
000009de >9600                             LDAA    PIN                 DATE
000009e0  27e6                             BEQ     PINNV
000009e2  44                               LSRA
000009e3  44                               LSRA
000009e4  44                               LSRA
000009e5 >bd0000                           JSR     CBCD
000009e8  8130                             CMPA    #$3C
000009ea  2602                             BNE     DTN0
000009ec  8620                             LDAA    #$20
000009ee >fd0002                   DTN0    STD     DISP+2
000009f1  8131                             CMPA    #$31
000009f3  272a                             BEQ     NOTRD
000009f5  c131                             CMPB    #$31
000009f7  260a                             BNE     NOTST
000009f9  8673                             LDAA    #'s
000009fb >b70004                           STAA    DISP+4
000009fe  8674                             LDAA    #'t
00000a00 >b70005                           STAA    DISP+5
00000a03  c132                     NOTST   CMPB    #$32
00000a05  260a                             BNE     NOTND
00000a07  866e                             LDAA    #'n
00000a09 >b70004                           STAA    DISP+4
00000a0c  8664                             LDAA    #'d
00000a0e >b70005                           STAA    DISP+5
00000a11  c133                     NOTND   CMPB    #$33
00000a13  260a                             BNE     NOTRD
00000a15  8672                             LDAA    #'r
00000a17 >b70004                           STAA    DISP+4
00000a1a  8664                             LDAA    #'d
00000a1c >b70005                           STAA    DISP+5
00000a1f >9600                     NOTRD   LDAA    PIN                 HOURS
00000a21  8407                             ANDA    #7
00000a23 >d601                             LDAB    PIN+1
00000a25  58                               ASLB
00000a26  49                               ROLA
00000a27  58                               ASLB
00000a28  49                               ROLA
00000a29 >bd0000                           JSR     CBCD
00000a2c >fd000a                           STD     DISP+10
00000a2f >9601                             LDAA    PIN+1               MINUTES
00000a31  843f                             ANDA    #$3F
00000a33 >bd0000                           JSR     CBCD
00000a36 >fd000d                           STD     DISP+13
00000a39  39                               RTS

                                   ***************************************************
                                   *                                                 *
                                   *       MJD display.                              *
                                   *                                                 *
                                   ***************************************************

00000a3a  8d26                     DMJD    BSR     SMJD
00000a3c >9600                             LDAA    MJD
00000a3e  2721                             BEQ     MJDNV
00000a40  8b30                             ADDA    #$30
00000a42 >b7000a                           STAA    DISP+10
00000a45 >9601                             LDAA    MJD+1
00000a47  8b30                             ADDA    #$30
00000a49 >b7000b                           STAA    DISP+11
00000a4c >9602                             LDAA    MJD+2
00000a4e  8b30                             ADDA    #$30
00000a50 >b7000c                           STAA    DISP+12
00000a53 >9603                             LDAA    MJD+3
00000a55  8b30                             ADDA    #$30
00000a57 >b7000d                           STAA    DISP+13
00000a5a >9604                             LDAA    MJD+4
00000a5c  8b30                             ADDA    #$30
00000a5e >b7000e                           STAA    DISP+14
00000a61  39                       MJDNV   RTS

00000a62 >ce0000                   SMJD    LDX     #MJDST
00000a65 >18ce0000                         LDY     #DISP
00000a69  a600                     MLOP    LDAA    0,X
00000a6b  18a700                           STAA    0,Y
00000a6e  08                               INX
00000a6f  1808                             INY
00000a71 >188c000f                         CPY     #DISP+15
00000a75  23f2                             BLS     MLOP
00000a77  39                               RTS
```

```
                                  ***************************************************
                                  *                                                 *
                                  *       TA return display.                        *
                                  *                                                 *
                                  ***************************************************

00000a78 >9600                    DRET    LDAA    REARET
00000a7a  c610                            LDAB    #16
00000a7c  3d                              MUL
00000a7d >ce0000                          LDX     #TARET
00000a80  3a                              ABX
00000a81 >18ce0000                        LDY     #DISP
00000a85  a600                    RLOP    LDAA    0,X
00000a87  18a700                          STAA    0,Y
00000a8a  08                              INX
00000a8b  1808                            INY
00000a8d >188c000f                        CPY     #DISP+15
00000a91  23f2                            BLS     RLOP
00000a93  39                              RTS

                                  ***************************************************
                                  *                                                 *
                                  *       Sleep and M/S & DI displays.              *
                                  *                                                 *
                                  ***************************************************

00000a94 >ce0000                  SLEEPD  LDX     #SLPST
00000a97 >18ce0000                        LDY     #DISP
00000a9b  a600                    SLOP    LDAA    0,X
00000a9d  18a700                          STAA    0,Y
00000aa0  08                              INX
00000aa1  1808                            INY
00000aa3 >188c000f                        CPY     #DISP+15
00000aa7  23f2                            BLS     SLOP
00000aa9 >9600                            LDAA    SLEPT
00000aab >bd0000                          JSR     CBCD
00000aae >fd0008                          STD     DISP+8
00000ab1  39                              RTS

00000ab2 >ce0000                  DMSD    LDX     #MSDST
00000ab5 >18ce0000                        LDY     #DISP
00000ab9  a600                    ILOP    LDAA    0,X
00000abb  18a700                          STAA    0,Y
00000abe  08                              INX
00000abf  1808                            INY
00000ac1 >188c000f                        CPY     #DISP+15
00000ac5  23f2                            BLS     ILOP
00000ac7 >13000805                        BRCLR · STAT5,$08,MSM
00000acb  864d                            LDAA    #'M
00000acd >b70006                          STAA    DISP+6
00000ad0 >9600                    MSM     LDAA    DI
00000ad2 >bd0000                          JSR     CBCD
00000ad5 >fd000d                          STD     DISP+13
00000ad8  39                      FNOK    RTS

                                  ***************************************************
                                  *                                                 *
                                  *       EON display.                              *
                                  *                                                 *
                                  ***************************************************

00000ad9 >bd0000                  DEON    JSR     SMJD                    CLEAR FREQUENCY CHARACTERS

00000adc >9600                            LDAA    RTDIS
00000ade  800a                            SUBA    #10
00000ae0  c610                            LDAB    #16
00000ae2  3d                              MUL
00000ae3 >ce0000                          LDX     #EON
00000ae6  3a                              ABX

00000ae7  8620                            LDAA    #$20
00000ae9 >b70008                          STAA    DISP+8
00000aec >b70009                          STAA    DISP+9
00000aef  a602                            LDAA    2,X
00000af1 >b70000                          STAA    DISP
00000af4  a603                            LDAA    3,X
00000af6 >b70001                          STAA    DISP+1
00000af9  a604                            LDAA    4,X
00000afb >b70002                          STAA    DISP+2
00000afe  a605                            LDAA    5,X
00000b00 >b70003                          STAA    DISP+3
00000b03  a606                            LDAA    6,X
00000b05 >b70004                          STAA    DISP+4
00000b08  a607                            LDAA    7,X
00000b0a >b70005                          STAA    DISP+5
00000b0d  a608                            LDAA    8,X
00000b0f >b70006                          STAA    DISP+6
00000b12  a609                            LDAA    9,X
00000b14 >b70007                          STAA    DISP+7

00000b17  a60d                            LDAA    13,X

00000b19  81cd                            CMPA    #205                    FILLER ?
00000b1b  2603                            BNE     NFIL
00000b1d  08                              INX
00000b1e  a60d                            LDAA    13,X                    YES, TRY AGAIN
00000b20  81fa                    NFIL    CMPA    #250                    MEDIUM/LONG ?
00000b22  2718                            BEQ     MLWF

00000b24  81cc                            CMPA    #204                    FREQUENCY OK ?
00000b26  22b0                            BHI     FNOK
00000b28  c60a                    FOK2    LDAB    #10
00000b2a  3d                              MUL
00000b2b  cb2e                            ADDB    #$2E
00000b2d >d700                            STAB    W1
00000b2f  8922                            ADCA    #$22
00000b31 >9700                            STAA    W2
00000b33 >bd0000                          JSR     DCON2
00000b36 >bd0000                          JSR     TYPE3
00000b39 >7e0000                          JMP     NEW                     RESTORE Q
```

```
                                 ***************************************************
                                 *                                                 *
                                 *       Medium/longwave EON display.              *
                                 *                                                 *
                                 ***************************************************

00000b3c  08                     MLWF    INX                          DISPLAY M/L EON FREQUENCY
00000b3d  a60d                           LDAA    13,X
00000b3f  810f                           CMPA    #15
00000b41  2302                           BLS     LONG
00000b43  8b1b                           ADDA    #27                  MW OFFSET
00000b45  8b10                   LONG    ADDA    #16                  M/L OFFSET
00000b47  c609                           LDAB    #9
00000b49  3d                             MUL
00000b4a >d700                           STAB    W1
00000b4c >9700                           STAA    W2
00000b4e >bd0000                         JSR     DCON2                CONVERT TO BCD IN RQ
00000b51 >9602                           LDAA    RQ+2
00000b53  2602                           BNE     NZ3                  IF THOUSANDS OF kHz A ZERO
00000b55  86f0                           LDAA    #$F0                 DISPLAY AS A SPACE
00000b57  8b30                   NZ3     ADDA    #$30
00000b59 >b70009                         STAA    DISP+9
00000b5c >9603                           LDAA    RQ+3
00000b5e  8b30                           ADDA    #$30
00000b60 >b7000a                         STAA    DISP+10
00000b63 >9604                           LDAA    RQ+4
00000b65  8b30                           ADDA    #$30
00000b67 >b7000b                         STAA    DISP+11
00000b6a >9605                           LDAA    RQ+5
00000b6c  8b30                           ADDA    #$30
00000b6e >b7000c                         STAA    DISP+12
00000b71  866b                           LDAA    #'k
00000b73 >b7000d                         STAA    DISP+13
00000b76  8648                           LDAA    #'H
00000b78 >b7000e                         STAA    DISP+14
00000b7b  867a                           LDAA    #'z
00000b7d >b7000f                         STAA    DISP+15
00000b80 >7e0000                         JMP     NEW                  RESTORE Q

                                 ***************************************************
                                 *                                                 *
                                 *       Clear PS-name after confidence loss.      *
                                 *                                                 *
                                 ***************************************************

00000b83 >ce0000                 CLRPS   LDX     #PSN                 CLEAR PS-NAME
00000b86  86ff                           LDAA    #$FF                 TO '-'s
00000b88  a700                   PLOP3   STAA    0,X
00000b8a  08                             INX
00000b8b >8c0008                         CPX     #PSN+8
00000b8e  26f8                           BNE     PLOP3
00000b90  39                             RTS

                                 ***************************************************
                                 *                                                 *
                                 *       Split A nibbles into B (LS) and A (MS).   *
                                 *                                                 *
                                 ***************************************************

00000b91  16                     SPLIT   TAB                          MSD INTO A, LSD INTO B
00000b92  0d                             SEC
00000b93  46                             RORA
00000b94  0d                             SEC
00000b95  46                             RORA
00000b96  44                             LSRA
00000b97  44                             LSRA
00000b98  8139                           CMPA    #$39
00000b9a  2302                           BLS     XOK
00000b9c  8b07                           ADDA    #7
00000b9e  c40f                   XOK     ANDB    #$0F
00000ba0  cb30                           ADDB    #$30
00000ba2  c139                           CMPB    #$39
00000ba4  2302                           BLS     AOK
00000ba6  cb07                           ADDB    #7
00000ba8  39                     AOK     RTS

                                 ***************************************************
                                 *                                                 *
                                 *       Send and clock data to LCD module.        *
                                 *                                                 *
                                 *       Check to see if LCD module is busy.       *
                                 *                                                 *
                                 ***************************************************

00000ba9  18ce1000               CLOCK   LDY     #$1000
00000bad  18a703                         STAA    PORTC,Y
00000bb0  181c0480                       BSET    PORTB,Y,$80
00000bb4  181d0480                       BCLR    PORTB,Y,$80          CLOCK IT
00000bb8  39                             RTS

00000bb9  18ce1000               WAIT    LDY     #$1000
00000bbd  181d04a0                       BCLR    PORTB,Y,$A0          READ LCD MODULE BUSY FLAG
00000bc1  181c0440                       BSET    PORTB,Y,$40
00000bc5  186f07                         CLR     PORTCD,Y             INPUT ON PORTC
00000bc8  181c0480               WLOOP   BSET    PORTB,Y,$80          CLOCK HIGH
00000bcc  01                             NOP
00000bcd  18a603                         LDAA    PORTC,Y              READ MODULE
00000bd0  181d0480                       BCLR    PORTB,Y,$80          CLOCK LOW
00000bd4 >9700                           STAA    W7
                                 *       BRSET   PORTD,Y,$02,NOTEST   **TEST**
00000bd6 >120080ee                       BRSET   W7,$80,WLOOP         BUSY ?
00000bda  186307                 NOTEST  COM     PORTCD,Y             OUTPUT ON PORTC
00000bdd  181d0440                       BCLR    PORTB,Y,$40
00000be1  39                             RTS
```

```
                            ****************************************************
                            *                                                  *
                            *       Hex->BCD conversion (& decimal adjust).    *
                            *                                                  *
                            ****************************************************

00000be2  16                CBCD    TAB                             HEX IN A & B
00000be3  840f                      ANDA   #$0F                     LSB IN A
00000be5  c4f0                      ANDB   #$F0                     MSB (x16) IN B
00000be7  8b00                      ADDA   #0
00000be9  19                        DAA
00000bea  c010              MOREB   SUBB   #$10                     DECREMENT MSB
00000bec  2505                      BCS    BDONE                    TOO FAR ?
00000bee  8b16                      ADDA   #$16                     NO, ADD 16 TO A,
00000bf0  19                        DAA                             ADJUST,
00000bf1  20f7                      BRA    MOREB                    AND TRY AGAIN
00000bf3 >7e0000            BDONE   JMP    SPLIT

                            ************************************************
                            *                                              *
                            *       Programme Type (PTY) Codes.            *
                            *                                              *
                            ************************************************

00000bf6  6e6f2070726f6772  PTYT    FCC    'no program type '  0
00000c06  202020202020204e65        FCC    '      News      '  1
00000c16  43757272656e7420          FCC    'Current affairs '  2
00000c26  2020496e666f726d          FCC    '  Information   '  3
00000c36  202020202053706f          FCC    '     Sport      '  4
00000c46  2020204564756361          FCC    '   Education    '  5
00000c56  2020202020447261          FCC    '     Drama      '  6
00000c66  202020204375 6c74         FCC    '    Culture     '  7
00000c76  2020202053636965          FCC    '    Science     '  8
00000c86  2020202020566172          FCC    '     Varied     '  9
00000c96  202020506f70206d          FCC    '   Pop music    '  10
00000ca6  202020526f636b20          FCC    '   Rock music   '  11
00000cb6  2045617379206c69          FCC    ' Easy listening '  12
00000cc6  204c696768742063          FCC    ' Light classics '  13
00000cd6  536572696f757320          FCC    'Serious classics'  14
00000ce6  20204f7468657220          FCC    '   Other music  '  15

                            ************************************************
                            *                                              *
                            *       Clear EON data.                        *
                            *                                              *
                            ************************************************

00000cf6 >ce0000            CLREON  LDX    #EON
00000cf9  86ff                      LDAA   #$FF
00000cfb  a700              ELOP    STAA   0,X                      EON RAM CLEAR
00000cfd  08                        INX
00000cfe >8c0100                    CPX    #EON+256
00000d01  26f8                      BNE    ELOP
00000d03  39                        RTS

                            ************************************************
                            *                                              *
                            *       LCD initialisation.                    *
                            *                                              *
                            ************************************************

00000d04 >7f0000            INITD   CLR    PIN                      CLEAR
00000d07 >7f0001                    CLR    PIN+1                    PIN,
00000d0a >7f0000                    CLR    DI                       DI,
00000d0d >150008                    BCLR   STAT5,$08                M/S BIT,
00000d10 >7f0000                    CLR    PTY                      PTY,
00000d13 >150008                    BCLR   STAT3,$08                AND TP FLAG
00000d16 >13000103                  BRCLR  STAT3,$01,INITR          OFF STATION ?
00000d1a >bd0000                    JSR    CLRPS                    YES, CLEAR PS-NAME

00000d1d  86a0              INITR   LDAA   #$AC                     CLEAR RT
00000d1f >b70000                    STAA   RT                       INITIALSIE SPACES BEFORE RT
00000d22 >b70001                    STAA   RT+1
00000d25 >b70003                    STAA   RT+3
00000d28 >b70004                    STAA   RT+4
00000d2b  862d                      LDAA   #$2D
00000d2d >b70002                    STAA   RT+2                     AND -
00000d30  8620                      LDAA   #$20                     INITIALISE RADIOTEXT TO SPACES
00000d32 >ce0000                    LDX    #RT                      AFTER CONFIDENCE LOSS OR TEXT A/B CHANGE
00000d35  a705              CLOP    STAA   5,X
00000d37  08                        INX
00000d38 >8c0040                    CPX    #RT+64
00000d3b  26f8                      BNE    CLOP
00000d3d >7f0000                    CLR    DISP1                    INITIALISE SCROLLING POINTERS
00000d40 >7f0000                    CLR    DISP2
00000d43 >150004                    BCLR   STAT2,$04                CANCEL RT DISPLAY
00000d46  39                        RTS

00000d47  2020416c61726d20  ALARMF  FCC    '  Alarm -  OFF  '
00000d57  372044617920416c  ALARMN  FCC    '7 Day Alarm ----'
00000d67  20504920636f6465  PIST    FCC    ' PI code -      '
00000d77  6c61737420544120  ONPIST  FCC    'last TA PI
00000d87  205450202d203020  TAPST   FCC    ' TP - 0  TA - 0 '
00000d97  2050494e206e6f2e  PINST1  FCC    ' PIN no. -      '
00000da7  2020202074682061  PINST2  FCC    '    th at --.-- '
00000db7  204d4a2064617920  MJDST   FCC    ' MJ day -       '
00000dc7  20536c6565702020  SLPST   FCC    ' Sleep   0 min. '
00000dd7  204d2f5320205320  MSDST   FCC    ' M/S  S   DI  0 '
00000de7  20313020536e6f6f  SNOZ    FCC    ' 10 Snooze --.--'         NOT USED

00000df7  5441207274726e3a  TARET   FCC    'TA rtrn:
00000e07  544120696e68623a          FCC    'TA inhb:  flag  '    1
00000e17  5441207274726e3a          FCC    'TA rtrn: signal '    2  NOT USED
00000e27  5441207274726e3a          FCC    'TA rtrn: PI code'    3
00000e37  5441207274726e3a          FCC    'TA rtrn: TA low '    4
00000e47  5441207274726e3a          FCC    'TA rtrn: TP low '    5
00000e57  544120696e68623a          FCC    'TA inhb: ill frq'    6  NOT USED
00000e67  544120696e68623a          FCC    'TA inhb: EON PI '    7
00000e77  544120696e68623a          FCC    'TA inhb:   NVM  '    8
00000e87  5441207274726e3a          FCC    'TA rtrn: manual '    9
```

```
                                    ***************************************************
                                    *                                                 *
                                    *               VFD character set.                *
                                    *                                                 *
                                    *       Position in table is ASCII value.         *
                                    *       Entry is the VFD character used.          *
                                    *       Last column shows characters replaced     *
                                    *       by spaces. $00 to $1F are ASCII control   *
                                    *       characters and shouldn't occur.           *
                                    *       / & : have been entered as -              *
                                    *       " has been entered as '                   *
                                    *                                                 *
                                    ***************************************************

00000e97  7e7e7e7e                  VTAB    FCB     $7E,$7E,$7E,$7E                 all
00000e9b  7e7e7e7e                          FCB     $7E,$7E,$7E,$7E                 all
00000e9f  7e7e7e7e                          FCB     $7E,$7E,$7E,$7E                 all
00000ea3  7e7e7e7e                          FCB     $7E,$7E,$7E,$7E                 all

00000ea7  7e7e7e7e                          FCB     $7E,$7E,$7E,$7E                 all
00000eab  7e7e7e7e                          FCB     $7E,$7E,$7E,$7E                 all
00000eaf  7e7e7e7e                          FCB     $7E,$7E,$7E,$7E                 all
00000eb3  7e7e7e7e                          FCB     $7E,$7E,$7E,$7E                 all

00000eb7  7e7b7a7e                          FCB     $7E,$7B,$7A,$7E       !  "  #   #
00000ebb  7e7e7e7a                          FCB     $7E,$7E,$7E,$7A    $  %  &  '   $%&
00000ebf  7e7e7e7e                          FCB     $7E,$7E,$7E,$7E    (  )  *  +   all
00000ec3  3f7d3e7d                          FCB     $3F,$7D,$3E,$7D    ,  -  .  /

00000ec7  00010203                          FCB     $00,$01,$02,$03    0  1  2  3
00000ecb  04050607                          FCB     $04,$05,$06,$07    4  5  6  7
00000ecf  08097d7e                          FCB     $08,$09,$7D,$7E    8  9  :  ;   ;
00000ed3  7e7e7e7c                          FCB     $7E,$7E,$7E,$7C    <  =  >  ?   <=>

00000ed7  7e0a0b0c                          FCB     $7E,$0A,$0B,$0C    @  A  B  C   @
00000edb  0d0e0f10                          FCB     $0D,$0E,$0F,$10    D  E  F  G
00000edf  11121314                          FCB     $11,$12,$13,$14    H  I  J  K
00000ee3  15161718                          FCB     $15,$16,$17,$18    L  M  N  O

00000ee7  191a1b1c                          FCB     $19,$1A,$1B,$1C    P  Q  R  S
00000eeb  1d1e1f20                          FCB     $1D,$1E,$1F,$20    T  U  V  W
00000eef  2122237e                          FCB     $21,$22,$23,$7E    X  Y  Z  [   [
00000ef3  7e7e7e7d                          FCB     $7E,$7E,$7E,$7D    \  ]  ^  -   \]^

00000ef7  7a242526                          FCB     $7A,$24,$25,$26    `  a  b  c
00000efb  2728292a                          FCB     $27,$28,$29,$2A    d  e  f  g
00000eff  2b2c2d2e                          FCB     $2B,$2C,$2D,$2E    h  i  j  k
00000f03  2f303132                          FCB     $2F,$30,$31,$32    l  m  n  o

00000f07  33343536                          FCB     $33,$34,$35,$36    p  q  r  s
00000f0b  3738393a                          FCB     $37,$38,$39,$3A    t  u  v  w
00000f0f  3b3c3d7e                          FCB     $3B,$3C,$3D,$7E    x  y  z  {   {
00000f13  7e7e7e7e                          FCB     $7E,$7E,$7E,$7E    |  }  -      all

                                            END


                 Section synopsis

1 000000ae (            174) .RAM1
2 00000100 (            256) .RAM2
3 0000006d (            109) .RAM3
4 00000f17 (           3863) .ROM3
```

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         Symbol table

.RAM1      1 00000000 | DIS3       4 00000679 | LT60       4 00000392 | NPIN1      4 00000580 | RDSTO      1 00000049
.RAM2      2 00000000 | DIS4       4 00000680 | M8A        4 000005fd | NPIN2      4 00000589 | REARET     1 000000a2
.RAM3      3 00000000 | DIS5       4 00000645 | MIN        1 00000070 | NPS        4 00000423 | RLOP       4 00000a85
.ROM3      4 00000000 | DISP       3 00000000 | MJD        1 00000030 | NPTY       4 00000565 | ROW1       4 000005d0
ADD      I 0 00000000 | DISP1      1 00000074 | MJDAT    E 4 000004cf | NRET       4 000005ad | RP         1 0000007c
ADD20      4 000008a4 | DISP2      1 00000075 | MJDC     I 0 00000000 | NRMD       4 000005c4 | RQ         1 00000076
ADDON      4 000003e1 | DISPP      3 00000010 | MJDNV      4 00000a61 | NTAP       4 00000577 | RR         1 00000082
ALARMF     4 00000d47 | DIST       1 00000047 | MJDST      4 00000db7 | NTD        4 000002ae | RT         3 00000028
ALARMN     4 00000d57 | DITAP      4 0000097c | MLOP       4 00000a69 | NTSCN2     4 0000072b | RTDIS      1 000000a3
ALOF       4 0000097b | DLOP       4 00000904 | MLWF       4 00000b3c | NUM1       1 0000009b | RTDSP      4 00000807
ALOFD      4 0000092e | DLOPO      4 00000850 | MNAME    I 0 00000000 | NUM2       1 0000009d | RTITS      4 000005b2
ALOP       4 00000932 | DMJD       4 00000a3a | MNTH       1 00000042 | NWR        4 00000025 | S02        4 00000130
ALOP2      4 000008ed | DMSD       4 00000ab2 | MOD      E 4 0000053a | NWR2       4 0000002c | S03        4 000000f2
ALRMA      4 000008cc | DNAME    I 0 00000000 | MOREB      4 00000bea | NXT        4 0000080e | S12        4 00000138
ALRMD      4 00000924 | DNDX       4 00000245 | MPS        4 00000709 | NXTJ       4 00000503 | S13        4 000000fa
ALRMJ      4 000005cd | DOM        1 00000044 | MSDST      4 00000dd7 | NZ1        4 00000761 | S22        4 00000140
AMD        4 000007ac | DONPI      4 00000849 | MSM        4 00000ad0 | NZ1A       4 000007b7 | S23        4 00000102
AMIN       1 00000072 | DOW        1 00000046 | MSZ        4 000002f3 | NZ1B       4 000006d9 | S32        4 00000148
AOK        4 00000ba8 | DPIN1      4 000009a1 | MTHZ       4 000008b1 | NZ2        4 00000770 | S33        4 0000010a
AOUR       1 00000073 | DPIN2      4 000009c9 | MUX8       4 00000631 | NZ2A       4 000007c6 | S42        4 00000150
BCTO       1 000000ac | DRET       4 00000a78 | N14B       4 00000053 | NZ2B       4 000006e8 | S43        4 00000110
BDONE      4 00000bf3 | DTNO       4 000009ee | N5D        4 0000094d | NZ3        4 00000b57 | S52        4 00000158
BIT        1 00000068 | ELOP       4 00000cfb | NALOF      4 00000967 | ONPIST     4 00000d77 | S53        4 00000118
BLOP       4 00000983 | EON        2 00000000 | NCH        4 00000324 | OUR        1 00000071 | S62        4 0000015e
BMJD       1 00000000 | FH         4 00000975 | NCJ        4 00000735 | OUT1       4 000003e3 | S63        4 00000120
BOK        4 000004b5 | FIN        4 0000016e | NEG        4 00000381 | OUT2       4 000004aa | S72        4 00000166
CARRY      1 00000099 | FMD        4 0000075b | NEW      I 0 00000000 | OUT3       4 000004a7 | S73        4 00000128
CBCD     E 4 00000be2 | FNOK       4 00000ad8 | NFIL       4 00000b20 | P          1 00000015 | SCHAN      1 000000a5
CCBH       4 000000b3 | FOK2       4 00000b28 | NMJD       4 00000592 | PI         1 00000061 | SCNG       4 0000070e
CJ         4 00000747 | FOUR       4 00000012 | NMLW       4 00000443 | PIN        1 00000065 | SCNT       1 000000ad
CJP        4 00000745 | FSP        4 0000082c | NMR        4 00000203 | PINNV      4 000009c8 | SDATA    E 4 000000b7
CLCK       4 00000037 | GROUP      1 00000057 | NMSD       4 0000059b | PINST1     4 00000d97 | SEC        1 0000006f
CLOCK    E 4 00000ba9 | GRP0       4 0000027f | NNOW       4 000001d7 | PINST2     4 00000da7 | SHAFT    I 0 00000000
CLOP       4 00000d35 | GRP1       4 000002fe | NOCL       4 00000544 | PINV       4 00000923 | SKCL       4 00000788
CLOP2      4 000005d3 | GRP14A     4 000003ee | NONPI      4 000005a4 | PINVO      4 0000086f | SKCL2      4 000007a8
CLRAS    I 0 00000000 | GRP14B     4 00000484 | NORMD      4 0000069f | PION       1 00000063 | SKP1       4 00000826
CLREON   E 4 00000cf6 | GRP2       4 0000030d | NOT0       4 000002c2 | PIST       4 00000d67 | SKPDC      4 000001d8
CLRPS      4 00000b83 | GRP4       4 00000348 | NOT1       4 000002cf | PLOP       4 000009a8 | SLEEPD     4 00000a94
CLTR     I 0 00000000 | HDON       4 000003ca | NOT2       4 000002dc | PLOP2      4 000009d0 | SLEPT      1 00000048
CMIN       4 000007ef | ILOP       4 00000ab9 | NOT3       4 000002e9 | PLOP3      4 00000b88 | SLOP       4 00000a9b
COK        4 00000620 | ILP1       4 00000839 | NOT4       4 000001db | POS        4 000003b7 | SLPD       4 000005bb
COK2       4 00000530 | INITD    E 4 00000d04 | NOT5       4 0000007b | PR14B      4 00000480 | SLPST      4 00000dc7
CONF       1 0000006c | INITF      4 00000698 | NOTC       4 000000aa | PRGMD      4 000007e1 | SMEM       1 000000a0
CONT       4 00000834 | INITR      4 00000d1d | NOTD       4 000000a7 | PROC     E 4 00000239 | SMJD       4 00000a62
COUNT      1 0000009a | ITMP1      1 00000069 | NOTEST     4 00000bda | PROC1      4 000002f6 | SNOZ       4 00000de7
CPS        4 000006c4 | KEY        1 00000096 | NOTFF      4 0000065f | PROC14     4 000003e7 | SPCE       4 00000743
CSEC       4 000007f7 | KOUNT      1 00000097 | NOTFM      4 000000e7 | PROC2      4 00000309 | SPLIT      4 00000b91
D7         4 000008d6 | LCD        4 0000060f | NOTH       4 00000467 | PROC4      4 00000341 | STAT       1 000000a6
DAT        1 0000004b | LCD3       4 000004c0 | NOTH1      4 00000475 | PSN        3 00000020 | STAT2      1 000000a7
DCON2    I 0 00000000 | LCD4       4 00000848 | NOTHN      4 00000394 | PSNP       1 0000004a | STAT3      1 000000a8
DDC        4 00000803 | LCD401     4 00000516 | NOTHP      4 000003cc | PTY        1 0000005f | STAT4      1 000000a9
DECC       4 000001d4 | LCD41      4 00000521 | NOTND      4 00000a11 | PTYCMP     1 00000060 | STAT5      1 000000aa
DEL        4 00000691 | LCDINI     4 00000321 | NOTODAY    4 00000874 | PTYD       4 000004ae | STAT6      1 000000ab
DEON       4 00000ad9 | LED        1 0000009f | NOTP       4 000006b0 | PTYL       4 00000253 | STBYD      4 00000870
DHIGH      4 000000d2 | LEV        1 00000067 | NOTRD      4 00000a1f | PTYT       4 00000bf6 | SYN        1 0000006a
DI         1 000000a4 | LOCAL      4 0000037a | NOTSP      4 00000831 | Q          1 00000003 | TACK       4 00000290
DIFF       4 000005e0 | LONG       4 00000b45 | NOTST      4 00000a03 | R          1 00000027 | TAH        4 000002ab
DIG2       1 00000098 | LOOPJ      4 000004f0 | NOTV       4 000001bb | RDSD       4 000000c7 | TALOW      4 000009a0
DIPI       4 000008fd | LPIL       4 000003f8 | NPI        4 0000056e | RDSOK      4 00000066 | TAOH       4 00000499

TAPST      4 00000d87 | TMQ        1 0000000c | TRYC       4 0000019f | TYPE3      4 00000752 | W3         1 0000008c
TARET      4 00000df7 | TNZ        4 000007ec | TRYCD      4 000001af | VALID      4 000001ee | W4         1 0000008e
TEXTA      4 00000311 | TOOLS      4 00000451 | TRYD       4 000001dc | VC         4 000001b9 | W5         1 00000090
TEXTB      4 0000031a | TPL        4 00000263 | TRYPIN     4 00000453 | VFD        4 00000632 | W6         1 00000092
TFCC     E 4 000000ab | TPL1       4 00000260 | TRYRT      4 00000556 | VFD3       4 00000653 | W7         1 00000094
TGRP15     4 00000279 | TPLO       4 000003f5 | TT1        4 000003ab | VFDL       4 00000677 | WAIT     E 4 00000bb9
TH32       1 0000006d | TPLOW      4 00000999 | TT2        4 000003ae | VLD        4 000001f9 | WLOOP      4 00000bc8
TH8        1 0000006e | TRY1       4 000000e8 | TXLP       4 00000232 | VTAB       4 00000e97 | XFER       4 0000022f
TINTB    E 4 00000000 | TRY2       4 000000ec | TYP1       4 000006b7 | W1         1 00000088 | XOK        4 00000b9e
TMP        1 0000001e | TRYA       4 00000183 | TYP2       4 00000702 | W2         1 0000008a | YR         1 00000039
TMPGRP     1 0000004f | TRYB       4 00000191 | TYPE3      4 00000752
```

Appendix 2

```
                      ************************************************
                      *                                              *
                      *          MC68HC11 functions.                 *
                      *                                              *
                      *     Add, Subtract, Multiply, Divide,         *
                      *     MJD -> day, date, month and year         *
                      *                                              *
                      *  Used with RADE.S11, RDSE.S11 and RDRAME.S11. *
                      *                                              *
                      *     P. Topping            6th March '93      *
                      *                                              *
                      ************************************************

                              EXPORT  TRA,ADD,SUB,MULT,DIV,CLQ,CLRAS,ADD1,MJDC,DNAME,MNAME

                              LIB     RDRAME.S11

00000000              PORTA   EQU     $00             PORT A ADDRESS
00000004              PORTB   EQU     $04               "  B   "
00000003              PORTC   EQU     $03               "  C   "
00000008              PORTD   EQU     $08               "  D   "
0000000a              PORTE   EQU     $0A               "  E   "
00000007              PORTCD  EQU     $07             PORT C DATA DIRECTION REG.
00000009              PORTDD  EQU     $09               "  D "      "      "
00000024              TMSK2   EQU     $24
00000026              PACTL   EQU     $26
00000039              OPTION  EQU     $39
0000003d              INIT    EQU     $3D

00001000              RBO     EQU     $1000           REGISTER BLOCK OFFSET
0000003b              PPROG   EQU     $3B             EEPROM CONTROL REGISTER
00000009              ND      EQU     9               No. DIGITS

                              SECTION.S .RAM1,COMM

00000000              BMJD    RMB     3               BINARY MJD
00000003              Q       RMB     9               WORKING NUMBER 1 - RDS
0000000c              TMQ     RMB     9               SCRATCH
00000015              P       RMB     9               WORKING NUMBER 2 - RDS
0000001e              TMP     RMB     9               MULT. OVER. OR DIV. REMAINDER
00000027              R       RMB     9               WORKING NUMBER 3 - RDS
00000030              MJD     RMB     9               MODIFIED JULIAN DAY NUMBER
00000039              YR      RMB     9               YEAR
00000042              MNTH    RMB     2               MONTH
00000044              DOM     RMB     2               DATE
00000046              DOW     RMB     1               DAY OF WEEK

                      ****************************************
                      *                                      *
                      *      RAM allocation, RDS & radio.    *
                      *                                      *
                      ****************************************

00000047              DIST    RMB     1               TRANSIENT DISPLAY TIMEOUT COUNTER
00000048              SLEPT   RMB     1               SLEEP TIMER MINUTES COUNTER
00000049              RDSTO   RMB     1               RDS TIMEOUT COUNTER
0000004a              PSNP    RMB     1               PS DISPLAY POINTER
0000004b              DAT     RMB     4               SERIAL DATA BUFFER
0000004f              TMPGRP  RMB     8               TEMPORARY GROUP DATA
00000057              GROUP   RMB     8               COMPLETE GROUP DATA
0000005f              PTY     RMB     1               PROGRAM-TYPE CODE (CURRENT)
00000060              PTYCMP  RMB     1               PROGRAM-TYPE CODE (PTY SCAN)
00000061              PI      RMB     2               PROGRAM IDENTIFICATION CODE
00000063              PION    RMB     2               PROGRAM IDENTIFICATION CODE (EON)
00000065              PIN     RMB     2               PROGRAM ITEM NUMBER
00000067              LEV     RMB     1               VALID BLOCK LEVEL
00000068              BIT     RMB     1               BIT LEVEL
00000069              ITMP1   RMB     1               TEMP BYTE FOR USE IN IRQ
0000006a              SYN     RMB     2               SYNDROME
0000006c              CONF    RMB     1               SYNDROME CONFIDENCE
0000006d              TH32    RMB     1               TICS (SECONDS/32)
0000006e              TH8     RMB     1               EIGHTHS OF SECONDS
0000006f              SEC     RMB     1               SECONDS
00000070              MIN     RMB     1               MINUTES
00000071              OUR     RMB     1               HOURS
00000072              AMIN    RMB     1               ALARM MINUTES
00000073              AOUR    RMB     1               ALARM HOURS
00000074              DISP1   RMB     1               RT DISPLAY POINTER #1
00000075              DISP2   RMB     1               RT DISPLAY POINTER #2

00000076              RQ      RMB     6               WORKING BCD NUMBER 1 RADIO
0000007c              RP      RMB     6                  "     "    "    2   "
00000082              RR      RMB     6                  "     "    "    3   "
00000088              W1      RMB     2               W
0000008a              W2      RMB     2               O
0000008c              W3      RMB     2               R
0000008e              W4      RMB     2               K
00000090              W5      RMB     2               I
00000092              W6      RMB     2               N
00000094              W7      RMB     2               G
00000096              KEY     RMB     1               CODE OF PRESSED KEY
00000097              KOUNT   RMB     1               KEYBOARD COUNTER
00000098              DIG2    RMB     1               2nd DIGIT TIMEOUT COUNTER
00000099              CARRY   RMB     1               BCD CARRY
0000009a              COUNT   RMB     1               LOOP COUNTER
0000009b              NUM1    RMB     2               1ST No. POINTER (ADD & SUBTRACT)
0000009d              NUM2    RMB     2               2ND No. POINTER (ADD & SUBTRACT)
0000009f              LED     RMB     1               STATION NUMBER
000000a0              SMEM    RMB     2               CURRENT FREQUENCY
000000a2              REARET  RMB     1               LAST TA REASON FOR RETURN
000000a3              RTDIS   RMB     1               RDS DISPLAY TYPE
000000a4              DI      RMB     1               DECODER IDENTIFICATION
000000a5              SCHAN   RMB     1               SCAN CHANNEL
```

```
                        ********************************************
                        *                                          *
                        *      Flags, & pages 1-2.                 *
                        *                                          *
                        ********************************************

000000a6                STAT    RMB     1               0: MODE 1: STATION, 0: FREQ
                        *                               1: STEP 1: 50KHz, 0: 10KHz
                        *                               2: CLRQ 1: CLEAR IF NO. KEYED
                        *                               3: TIMER MS BIT TOGGLE (64 Hz)
                        *                               4: RDS DATA CLEARING ENABLE
                        *                               5: KEY FUNCTION PERFORMED
                        *                               6: KEY REPEATING
                        *                               7: NOT JUST POWERED UP
000000a7                STAT2   RMB     1               0: VALID SYNDROME
                        *                               1: VALID GROUP
                        *                               2: RT DISPLAY
                        *                               3: UPDATE DISPLAY
                        *                               4: CLEAR DISPLAY
                        *                               5: SPACE FLAG
                        *                               6: NOT ON PROGRAM (AM)
                        *                               7: TA RETUNE DONE
000000a8                STAT3   RMB     1               0: NOT ON PROGRAM (FM)
                        *                               1: TEXTA/TEXTB BIT (RT)
                        *                               2: TA FLAG
                        *                               3: TP FLAG
                        *                               4: SHAFT DIRECTION
                        *                               5: SHAFT ROTATION
                        *                               6: UPDATE DATE
                        *                               7: SHAFT INTERRUPTS
000000a9                STAT4   RMB     1               0: DISPLAY (OR TA SWITCH) TRANSIENT
                        *                               1: SLEEP TIMER RUNNING
                        *                               2: TRAFFIC ENABLED
                        *                               3: ALARM DISPLAY
                        *                               4: ALARM ARMED
                        *                               5: ALARM SET-UP
                        *                               6: ALARM HOURS (SET-UP)
                        *                               7: VALID GROUP 14B RECEIVED
000000aa                STAT5   RMB     1               0: BAND CHANGE TIMEOUT
                        *                               1: RDS DISPLAYS
                        *                               2: SLEEP DISPLAY
                        *                               3: M/S 0: M, 1: S
                        *                               4: RETUNE FLAG (FREQUENCY MODE
                        *                               5: TA INHIBIT FLAG (NVM)
                        *                               6: STORE MODE
                        *                               7: WEEKDAY ONLY ALARM

000000ab                STAT6   RMB     1               BAND/BANK (FM IF, , , ,A1,A0,,E6;
000000ac                BCTO    RMB     1               BAND CHANGE TIMEOUT
000000ad                SCNT    RMB     1               SHAFT DETENT COUNTER

                                SECTION .RAM2,COMM
00000000                EON     RMB     256             EON DATA (16 NETWORKS)
                                SECTION .RAM3,COMM
00000000                DISP    RMB     16              LCD MODULE BUFFER
00000010                DISPP   RMB     16              CURRENT LCD MODULE CONTENTS
00000020                PSN     RMB     8
00000028                RT      RMB     69              RADIOTEXT

                                SECTION .ROM2

                        *****************************************************
                        *                                                   *
                        *       Transfer of BCD numbers.                    *
                        *                                                   *
                        *       (X) <- (NUM1), X preserved                  *
                        *                                                   *
                        *****************************************************

00000000 >df00          TRA     STX     NUM2            CLEAR DESTINATION
00000002 >bd0000                JSR     CLRAS           AND ADD IT TO No. AT NUM1

                        *****************************************************
                        *                                                   *
                        *       Addition of BCD numbers.                    *
                        *                                                   *
                        *       (X) <- (NUM1) + (NUM2), X preserved         *
                        *                                                   *
                        *****************************************************

00000005 >7f0000        ADD     CLR     CARRY
00000008 >df00                  STX     W7
0000000a >df00          AD      STX     W5              ANSWER POINTER
0000000c  c609                  LDAB    #ND
0000000e >de00                  LDX     NUM1            1st No. POINTER
00000010 >df00                  STX     W3
00000012 >de00                  LDX     NUM2            2nd No. POINTER
00000014 >df00                  STX     W4
00000016 >de00          LOOP    LDX     W3
00000018  a608                  LDAA    ND-1.X
0000001a  09                    DEX
0000001b >df00                  STX     W3
0000001d >de00                  LDX     W4
0000001f  ab08                  ADDA    ND-1.X          ADD
00000021  09                    DEX
00000022 >df00                  STX     W4
00000024 >9b00                  ADDA    CARRY           SET ON ADDITION OVERFLOW
00000026 >7f0000                CLR     CARRY           OR POS. RESULT SUBTRACTION
00000029  8d12                  BSR     ADJ             DECIMAL ADJUST
0000002b >de00                  LDX     W5
0000002d  a708                  STAA    ND-1.X          SAVE ANSWER
0000002f  09                    DEX
00000030 >df0C                  STX     W5
00000032  5a                    DECB
00000033  26e1                  BNE     LOOP            DONE ?
00000035 >de00                  LDX     W7
00000037  39                    RTS

00000038  800a          AJ      SUBA    #10             YES, SUTRACT 10
0000003a >7c0000                INC     CARRY           AND RECORD CARRY
0000003d  810a          ADJ     CMPA    #10
0000003f  24f7                  BHS     AJ              10 OR MORE ?
00000041  39                    RTS                     NC
```

```
                              ***************************************************
                              *                                                 *
                              *       Subtraction, complementing and incre-     *
                              *       menting (X=REG-ND) of BCD numbers.        *
                              *                                                 *
                              *       (X) <- (NUM1) - (NUM2), X preserved.      *
                              *       (X and NUM2 should not be equal)          *
                              *                                                 *
                              ***************************************************

00000042 >df00                SUB     STX     W6          ANSWER POINTER
00000044  8d08                        BSR     COM2        9S COMP. SECOND NUMBER
00000046 >7f0000                      CLR     CARRY       SET CARRY TO ONE
00000049 >7c0000                      INC     CARRY       BEFORE ADDING
0000004c  8dbc                        BSR     AD          ADD FIRST NUMBER

0000004e >de00                COM2    LDX     NUM2        9S COMPLIMENT
00000050  8d03                        BSR     COMP        SECOND NUMBER
00000052 >de00                        LDX     W6          RESTORE ANSWER POINTER
00000054  39                          RTS

00000055  c609                COMP    LDAB    #ND         9S COMPLIMENT
00000057  8609                LOOP3   LDAA    #$09
00000059  a008                        SUBA    ND-1,X
0000005b  a708                        STAA    ND-1,X
0000005d  09                          DEX
0000005e  5a                          DECB
0000005f  26f6                        BNE     LOOP3
00000061  39                          RTS

00000062  8df1                COM10   BSR     COMP        NINES COMPLIMENT THEN
00000064  c609                ADD1    LDAB    #ND         ADD 1 FOR TENS COMPLIMENT
00000066  6c11                ADD2    INC     2*ND-1,X    ENTER WITH X = REG-ND
00000068  a611                        LDAA    2*ND-1,X
0000006a  810a                        CMPA    #$0A
0000006c  2508                        BLO     RETURN
0000006e  800a                        SUBA    #10
00000070  a711                        STAA    2*ND-1,X
00000072  09                          DEX
00000073  5a                          DECB
00000074  26f0                        BNE     ADD2
00000076  39                  RETURN  RTS

                              ***************************************************
                              *                                                 *
                              *       Mult., R <- P x Q, over. in TMP, X = #R.  *
                              *                                                 *
                              ***************************************************

00000077 >ce0000              MULT    LDX     #R
0000007a >bd0000                      JSR     CLRAS
0000007d >ce0000                      LDX     #TMP
00000080 >bd0000                      JSR     CLRAS       CLEAR RESULT
00000083  ce0012                      LDX     #2*ND
00000086 >df00                        STX     W6          INIT. R POINTER
00000088  ce0009                      LDX     #ND
0000008b >a6ff                STR     LDAA    P-1,X
0000008d >df00                        STX     W1          SAVE P POINTER
0000008f >9700                        STAA    CARRY       SAVE P
                              *       BEQ     DCP
00000091  ce0009                      LDX     #ND         INIT. Q POINTER
00000094 >a6ff                XTT     LDAA    Q-1,X
00000096 >9700                        STAA    W4          SAVE Q
00000098  2733                        BEQ     TZ0         IF ZERO GOTO NEXT Q
0000009a >9600                        LDAA    CARRY       RECALL P
0000009c >9700                        STAA    W3          SAVE P
0000009e  4f                          CLRA
0000009f >740000              PLY     LSR     CARRY       RIGHT SHIFT INTO C
000000a2  2402                        BCC     SHF         C = ZERO ?
000000a4 >9b00                        ADDA    W4          NO, A=A+Q
000000a6 >7d000C              SHF     TST     CARRY       ZERO ?
000000a9  2705                        BEQ     C4          YES, FINISHED WITH THIS Q
000000ab >780000                      ASL     W4          NO, LEFT SHIFT Q
000000ae  20ef                        BRA     PLY
000000b0  09                  C4      DEX                 Q = Q + 1
000000b1 >df00                        STX     W2          SAVE Q POINTER
000000b3 >de00                        LDX     W6          R POINTER
000000b5 >abf6                        ADDA    R-ND-1,X    ADD R TO A                  WAS -(ND+1)
000000b7 >bd0000                      JSR     ADJ         ADJUST
000000ba >a7f6                C2      STAA    R-ND-1,X    R = R + A                   WAS -(ND+1)
000000bc >9600                        LDAA    CARRY
000000be >abf5                        ADDA    R-ND-2,X    ADD R-(ND+2) TO CARRY       WAS -(ND+2)
000000c0 >a7f5                        STAA    R-ND-2,X    R-(ND+2) = R-(ND+2) + CARRY WAS -(ND+2)
000000c2 >9600                        LDAA    W3          RECALL P
000000c4 >9700                        STAA    CARRY       SAVE IN CARRY
000000c6  09                          DEX
000000c7 >df00                        STX     W6          SAVE R POINTER
000000c9 >de00                        LDX     W2          Q POINTER
000000cb  2004                        BRA     C3
000000cd >7a0001              TZ0     DEC     W6+1        DEC. R POINTER
000000d0  09                          DEX                 DEC. Q POINTER
000000d1  26c1                C3      BNE     XTT
000000d3 >9601                        LDAA    W6+1        R POINTER
000000d5  8b08                        ADDA    #ND-1
000000d7 >9701                        STAA    W6+1        R = R + ND-1
                              *DCP    DEC     W6+1
000000d9 >de00                        LDX     W1
000000db  09                          DEX                 P = P + 1
000000dc  26ad                        BNE     STR         IF NOT ZERO GOTO NEXT P
000000de >ce0000                      LDX     #R
000000e1  39                          RTS
```

```
                          **************************************************
                          *                                                *
                          *       Division of BCD numbers.                 *
                          *                                                *
                          *       R <- P / Q, remainder in TMP.            *
                          *       on exit X = #R, TMQ used.                *
                          *                                                *
                          **************************************************

000000e2 >ce0000          DIV     LDX     #R            CLEAR
000000e5 >bd0000                  JSR     CLRAS         RESULT
                          *       CLR     W2            SIGN
000000e8 >ce0000                  LDX     #P            TRANSFER
000000eb >df00                    STX     NUM1          P TO
000000ed >ce0000                  LDX     #TMP          WORKING
000000f0 >bd0000                  JSR     TRA           P (TMP)
000000f3 >ce0000                  LDX     #Q            TRANSFER
000000f6 >df00                    STX     NUM1          Q TO
000000f8 >ce0000                  LDX     #TMQ          WORKING
000000fb >bd0000                  JSR     TRA           Q (TMQ)

000000fe  c609            POSS    LDAB    #ND           NUMBER DIGITS
00000100 >ce0000          LOOP6   LDX     #TMQ          FIND LEAST SIGNIFICANT
00000103  a600                    LDAA    0,X           NON-ZERO DIGIT
00000105  2607                    BNE     NOSH          ZERO ?
00000107 >bd0000                  JSR     SHIFT         YES, SHIFT Q
0000010a  26f4                    BNE     LOOP6         UP ONE PLACE
0000010c  2035            ZQ      BRA     RTRN          Q WAS ZERO
0000010e >7f0000          NOSH    CLR     W1            SAVE
00000111 >d701                    STAB    W1+1          No. DIDITS - No. SHIFTS

00000113 >ce0000          SUBB    LDX     #TMP          SUBTRACT Q
00000116 >df00                    STX     NUM1          FROM
00000118 >bd0000                  JSR     SUB           P
0000011b >9600                    LDAA    CARRY         TOO FAR ?
0000011d  2706                    BEQ     NEXTD         IF YES, GO TO NEXT DIGIT
0000011f >de00                    LDX     W1            INCREMENT RELEVANT
00000121 >6cff                    INC     R-1,X         DIGIT IN RESULT
00000123  20ee                    BRA     SUBB          ONCE AGAIN
00000125 >ce0000          NEXTD   LDX     #TMP          TOO FAR, ADD
00000128 >bd0000                  JSR     ADD           Q BACK ON
0000012b >ce0000          ROR     LDX     #TMQ          SET UP TO
0000012e  c608                    LDAB    #ND-1         SHIFT BACK WORKING Q
00000130  a607            RRJ     LDAA    ND-2,X        MOVE ALL
00000132  a708                    STAA    ND-1,X        DIGITS
00000134  09                      DEX                   DOWN
00000135  5a                      DECB                  ONE PLACE
00000136  26f8                    BNE     RRJ           LONE ?
00000138  6f08                    CLR     ND-1,X        CLEAR MS DIGIT
0000013a >7c0001                  INC     W1+1          INCREMENT POINTER
0000013d >9601                    LDAA    W1+1
0000013f  810a                    CMPA    #ND+1         FINISHED ?
00000141  26d0                    BNE     SUBB          NO, NEXT DIGIT
00000143 >ce0000          RTRN    LDX     #R
00000146  39                      RTS

                          ***************************************************************
                          *                                                             *
                          *       MJD - day of week and year.                           *
                          *                                                             *
                          *       DOW = (MJD+2)MOD7 (= WD-1)                     (DOW)  *
                          *       Y'  = INT((MJD-15078.2)/3652500)                (YR)  *
                          *                                                             *
                          ***************************************************************

00000147 >ce0000          MJDC    LDX     #MJD
0000014a >bd0000                  JSR     XFERP         P <- MTD
0000014d >ce0000                  LDX     #MJD
00000150 >bd0000                  JSR     T10K          MJD <- MJD TIMES 10,000

00000153 >ceff f7         DOFFW   LDX     #P-ND
00000156 >bd0000                  JSR     ADD1          P <- MJD + 1
00000159 >cefff7                  LDX     #P-ND
0000015c >bd0000                  JSR     ADD1          P <- MJD + 2
0000015f >ce0000                  LDX     #Q
00000162 >bd0000                  JSR     CLRAS
00000165  8607                    LDAA    #7
00000167 >9708                    STAA    Q+ND-1        Q <- 7
00000169 >bd0000                  JSR     DIV           R <- (MJD+2)/7
0000016c >9608                    LDAA    TMP+ND-1      REMAINDER (WD-1) IN TMP
0000016e >9700                    STAA    DOW

00000170 >ce0000          YEAR    LDX     #CY
00000173 >bd0000                  JSR     XFERQ         Q <- CY (150782000)
00000176 >ce0000                  LDX     #MJD          NUM2 <- (Q)
00000179 >df00                    STX     NUM1
0000017b >ce0000                  LDX     #P
0000017e >bd0000                  JSR     SUB           P <- 10K(MJD-15078.2)
00000181 >ce0000                  LDX     #DY
00000184 >bd0000                  JSR     XFERQ         Q <- 3652500
00000187 >bd0000                  JSR     DIV           R <- Y' ((MJD-15078.2)/365.25)
0000018a >df00                    STX     NUM1
0000018c >ce0000                  LDX     #YR
0000018f >bd0000                  JSR     TRA           YR <- Y'
```

```
                             **************************************************************
                             *                                                            *
                             *       MJD - month and day.                                 *
                             *                                                            *
                             *       M'= INT((MJD-14956.1-INT(Y'*365.25))/306001)     (P) *
                             *       D = MJD-14956-INT(Y'*365.25)-INT(M'*30.6001) (Q(x10K)) *
                             *                                                            *
                             **************************************************************

00000192 >bd0000             MONTH   JSR     INT             R <- 10K(INT(Y'*365.25))
00000195 >ce0000                     LDX     #DO1
00000198 >bd0000                     JSR     XFERP           P <- 149561000
0000019b >ce0000                     LDX     #MJD            NUM2 <- (P)
0000019e >df00                       STX     NUM1
000001a0 >ce0000                     LDX     #Q
000001a3 >bd0000                     JSR     SUB             Q <- 10K(MJD-14956.1)
000001a6 >df00                       STX     NUM1
000001a8 >ce0000                     LDX     #R
000001ab >df00                       STX     NUM2
000001ad >ce0000                     LDX     #P
000001b0 >bd0000                     JSR     SUB             P <- 10K(MJD-14956.1-INT(Y'*365.25))
000001b3 >ce0000                     LDX     #DM
000001b6 >bd0000                     JSR     XFERQ           Q <- 306001
000001b9 >bd0000                     JSR     DIV             R <- M'      ( MJD-14956.1-INT(Y'*365.25)  )
000001bc >bd0000                     JSR     XFERP           P <- M'  INT ( -------------------------  )
000001bf >9607                       LDAA    P+ND-2          SAVE M'      (          306001             )
000001c1 >9700                       STAA    MNTH
000001c3 >9608                       LDAA    P+ND-1
000001c5 >9701                       STAA    MNTH+1

000001c7 >bd0000             DAY     JSR     MULTI           R <- 10K(INT(M'*30.6001))
000001ca >df00                       STX     NUM1
000001cc >ce0000                     LDX     #TMQ
000001cf >bd0000                     JSR     TRA             TMQ <- 10K(INT(M'*30.6001))
000001d2 >bd0000                     JSR     INT             R <- 10K(INT(Y'*365.25))
000001d5 >df00                       STX     NUM2
000001d7 >ce0000                     LDX     #TMQ
000001da >df00                       STX     NUM1
000001dc >bd0000                     JSR     ADD             TMQ <- 10K(INT(Y'*365.25)+INT(M'*30.6001))
000001df >ce0000                     LDX     #DO1
000001e2 >bd0000                     JSR     XFERP           P <- 149561000
000001e5 >7f0005                     CLR     P+ND-4          P <- 149560000
000001e8 >ce0000                     LDX     #TMQ            NUM2 <- (P)
000001eb >df00                       STX     NUM1
000001ed >ce0000                     LDX     #R
000001f0 >bd0000                     JSR     ADD             R <- 10K(14956+INT(Y'*365.25)+INT(M'*30.6001))
000001f3 >df00                       STX     NUM2
000001f5 >ce0000                     LDX     #MJD
000001f8 >df00                       STX     NUM1
000001fa >ce0000                     LDX     #Q
000001fd >bd0000                     JSR     SUB             Q <- MJD-R (10K*DOM)
00000200  a604                       LDAA    ND-5,X
00000202 >9701                       STAA    DOM+1           MJD-14956-INT(Y'*365.25)-INT(M'*30.6001)
00000204  a603                       LDAA    ND-6,X
00000206 >9700                       STAA    DOM

                             **************************************************************
                             *                                                            *
                             *       MJD - final correction of year & month and subs.     *
                             *                                                            *
                             *       If M' = 14 or 15, then K = 1, else K = 0             *
                             *       Y = Y' + K                                           *
                             *       M = M' - 1 - K*12                                    *
                             *                                                            *
                             **************************************************************

00000208 >9600               ADJU    LDAA    MNTH            MONTH, MSD
0000020a  2720                       BEQ     KE02            0 ?
0000020c >9601                       LDAA    MNTH+1          NO, M'= 10 THRU 15
0000020e  2715                       BEQ     KE01            0 ?
00000210  8104                       CMPA    #4              NO, M'= 11 THRU 15
00000212  2518                       BLO     KE02            LESS THAN 14
00000214 >cefff7             KE1     LDX     #YR-ND          NO, M'= 14 OR 15, K=1
00000217 >bd0000                     JSR     ADD1            Y <- Y'+1
0000021a >7f0000                     CLR     MNTH            MONTH, MSD (-10)
0000021d >7a0001                     DEC     MNTH+1          DEC. MONTH
00000220 >7a0001                     DEC     MNTH+1          AND AGAIN (-2)
00000223  2007                       BRA     KE02            -12
00000225  860a               KE01    LDAA    #10             M'= 10
00000227 >9701                       STAA    MNTH+1          PUT 10 IN LSD
00000229 >7f0000                     CLR     MNTH            CLEAR MSD
0000022c >7a0001             KE02    DEC     MNTH+1          9<-10, 1,2<-14,15, 3-8<-4-9, 10-12<-11-13
0000022f  39                         RTS

00000230 >ce0000             INT     LDX     #YR
00000233  8d58                       BSR     XFERP           P <- Y'
00000235 >ce0000                     LDX     #DY
00000238  8d5b                       BSR     XFERQ           Q <- 10K*365.25
0000023a >bd0000             MULTI   JSR     MULT            R <- 10K*Y'*365.25
0000023d >7f0005                     CLR     R+ND-4
00000240 >7f0006                     CLR     R+ND-3
00000243 >7f0007                     CLR     R+ND-2
00000246 >7f0008                     CLR     R+ND-1          R <- 10K(INT(Y'*365.25))
00000249  39                         RTS

0000024a  c605               T10K    LDAB    #ND-4           TIMES 10,000
0000024c  a604               SLP     LDAA    4,X
0000024e  a700                       STAA    0,X
00000250  08                         INX
00000251  5a                         DECB
00000252  26f8                       BNE     SLP
00000254  6f00                       CLR     0,X
00000256  6f01                       CLR     1,X
00000258  6f02                       CLR     2,X
0000025a  6f03                       CLR     3,X
0000025c  39                         RTS
```

```
                               ***************************************************
                               *                                                 *
                               *       Clear, shift and MJD constants.           *
                               *                                                 *
                               ***************************************************

    0000025d >ce0000           CLQ     LDX     #Q              CLEAR Q
    00000260 >df00             CLRAS   STX     W5
    00000262  c609                     LDAB    #ND             CLEAR No. DIGITS STARTING AT X
    00000264  6f00             CR      CLR     0,X
    00000266  08                       INX
    00000267  5a                       DECB
    00000268  26fa                     BNE     CR              DONE ?
    0000026a >de00                     LDX     W5
    0000026c  39                       RTS

    0000026d >9700             SHIFT   STAA    W3
    0000026f  8d11                     BSR     DR1             W1: MSD, W2: LSD
    00000271 >de00                     LDX     W1
    00000273  a601             AGS     LDAA    1,X             MOVE ALL DIGITS
    00000275  a700                     STAA    0,X             UP ONE PLACE
    00000277  08                       INX
    00000278 >9c00                     CPX     W2
    0000027a  26f7                     BNE     AGS             DONE ?
    0000027c >9600                     LDAA    W3              YES, RECOVER NEW DIGIT
    0000027e  a700                     STAA    0,X             AND PUT IT IN LSD
    00000280  5a                       DECB
    00000281  39                       RTS

    00000282 >df00             DR1     STX     W1              STORE POINTERS
    00000284  8608                     LDAA    #ND-1           (USED IN DIGIT AND DQ)
    00000286  08               AXL     INX
    00000287  4a                       DECA
    00000288  26fc                     BNE     AXL
    0000028a >df00                     STX     W2
    0000028c  39                       RTS

    0000028d >df00             XFERP   STX     NUM1
    0000028f >ce0000                   LDX     #P
    00000292 >7e0000                   JMP     TRA             NUM2 <- (P)

    00000295 >df00             XFERQ   STX     NUM1
    00000297 >ce0000                   LDX     #Q
    0000029a >7e0000                   JMP     TRA             NUM2 <- (Q)

    0000029d  4d6f6e5475655765 DNAME   FCC     'MonTueWedThuFriSatSun'
    000002b2  696e76                   FCC     'inv'
    000002b5  4a616e4665624d61 MNAME   FCC     'JanFebMarAprMayJunJulAugSepOctNovDec'

    000002d9  0105000708020000 CY      FCB     1,5,0,7,8,2,0,0,0
    000002e2  0000030605020500 DY      FCB     0,0,3,6,5,2,5,0,0
    000002eb  0104090506010000 DO1     FCB     1,4,9,5,6,1,0,0,0
    000002f4  0000000300060000 DM      FCB     0,0,0,3,0,6,0,0,1

                                       END
```

```
                 Section synopsis

 1 000000ae (          174) .RAM1
 2 00000100 (          256) .RAM2
 3 0000006d (          109) .RAM3
 4 000002fd (          765) .ROM2
```

```
                 Symbol table

.RAM1          1 00000000 | COUNT          1 0000009a | KEY            1 00000096 | PSNP           1 0000004a | STAT4          1 000000a9
.RAM2          2 00000000 | CR             4 00000264 | KOUNT          1 00000097 | PTY            1 0000005f | STAT5          1 000000aa
.RAM3          3 00000000 | CY             4 000002d9 | LED            1 0000009f | PTYCMP         1 00000060 | STAT6          1 000000ab
.ROM2          4 00000000 | DAT            1 0000004b | LEV            1 00000067 | Q              1 00000003 | STR            4 0000008b
AD             4 0000000a | DAY            4 000001c7 | LOOP           4 00000016 | R              1 00000027 | SUB       E    4 00000042
ADD       E    4 00000005 | DI             1 000000a4 | LOOP3          4 00000057 | RDSTO          1 00000049 | SUBB           4 00000113
ADD1      E    4 00000064 | DIG2           1 00000098 | LOOP6          4 00000100 | REARET         1 000000a2 | SYN            1 0000006a
ADD2           4 00000066 | DISP           3 00000000 | MIN            1 00000070 | RETURN         4 00000076 | T10K           4 0000024a
ADJ            4 0000003d | DISP1          1 00000074 | MJD            1 00000030 | ROR            4 0000012b | TH32           1 0000006d
ADJU           4 00000208 | DISP2          1 00000075 | MJDC      E    4 00000147 | RP             1 0000007c | TH8            1 0000006e
AGS            4 00000273 | DISPP          3 00000010 | MNAME     E    4 000002b5 | RQ             1 00000076 | TMP            1 0000001e
AJ             4 00000038 | DIST           1 00000047 | MNTH           1 00000042 | RR             1 00000082 | TMPGRP         1 0000004f
AMIN           1 00000072 | DIV       E    4 000000e2 | MONTH          4 00000192 | RRJ            4 00000130 | TMQ            1 0000000c
AOUR           1 00000073 | DM             4 000002f4 | MULT      E    4 00000077 | RT             3 00000028 | TRA       E    4 00000000
AXL            4 00000286 | DNAME     E    4 0000029d | MULTI          4 0000023a | RTDIS          1 000000a3 | TZ0            4 000000cd
BCTO           1 000000ac | DO1            4 000002eb | NEXTD          4 00000125 | RTRN           4 00000143 | W1             1 00000088
BIT            1 00000068 | DOFFW          4 00000153 | NOSH           4 0000010e | SCHAN          1 000000a5 | W2             1 0000008a
BMJD           1 00000000 | DOM            1 00000044 | NUM1           1 0000009b | SCNT           1 000000ad | W3             1 0000008c
C2             4 000000ba | DOW            1 00000046 | NUM2           1 0000009d | SEC            1 0000006f | W4             1 0000008e
C3             4 000000d1 | DR1            4 00000282 | OUR            1 00000071 | SHF            4 000000a6 | W5             1 00000090
C4             4 000000b0 | DY             4 000002e2 | P              1 00000015 | SHIFT          4 0000026d | W6             1 00000092
CARRY          1 00000099 | EON            2 00000000 | PI             1 00000061 | SLEPT          1 00000048 | W7             1 00000094
CLQ       E    4 0000025d | GROUP          1 00000057 | PIN            1 00000065 | SLP            4 0000024c | XFERP          4 0000028d
CLRAS     E    4 00000260 | INT            4 00000230 | PION           1 00000063 | SMEM           1 000000a0 | XFERQ          4 00000295
COM10          4 00000062 | ITMP1          1 00000069 | PLY            4 0000009f | STAT           1 000000a6 | XTT            4 00000094
COM2           4 0000004e | KE01           4 00000225 | POSS           4 000000fe | STAT2          1 000000a7 | YEAR           4 00000170
COMP           4 00000055 | KE02           4 0000022c | PSN            3 00000020 | STAT3          1 000000a8 | YR             1 00000039
CONF           1 0000006c | KE1            4 00000214 | PSNF           1 0000004a
```

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