BINREP DKm

EMS-PDP-15
INTERNAL BINARY REPRESENTATION
KLAUS APPEL 3/3 1970

1. INTRODUCTION

THE PRESENT SPECIFICATION DESCRIBES THE INTERNAL REPRESENTATION OF INFORMATION IN THE EMS BUFFER AND REGISTER, ON EMS BINARY MAGNETIC TAPES, AND IN PDP-15 CORE STORAGE BEFORE IT IS TRANSFERRED TO EMS BY THE INTERFACE.

IT IS INTENDED FOR SYSTEMS PROGRAMMERS WHO WISH TO WRITE THEIR OWN PROGRAMS FOR THE PDP-15, OR FOR OTHER COMPUTERS TO WRITE MAGNETIC TAPES THAT CAN BE IMMEDIATELY PLAYED BY EMS, SUCH PROGRAMS MUST BE WRITTEN IN ASSEMBLER LANGUAGE (MACRO-15) BECAUSE OF THE COMPLICATED BINARY REPRESENTATION OF NUMERIC INFORMATION.

FORTRAN PROGRAMMERS CAN WRITE SUCH INFORMATION BY USING THE EMSALL PACKAGE OF SUBROUTINES. AS THE STUDIO IS EXPANDED TO INCLUDE NEW FUNCTIONS, THE PRESENT DESCRIPTION AS WELL AS THE EMSALL PACKAGE WILL BE UPDATED TO REFLECT THE CURRENT IMPLEMENTATION OF EMS. A VERSION CALLED EMSTOTAL IS ALSO AVAILABLE FOR THE CDC-3600 COMPUTER.

REFERENCE IS FURTHER MADE TO THE FOLLOWING DESCRIPTIONS:
EMSALL PROGRAM DESCRIPTION
EMS-PDP-15 INTERFACE PROGRAMMING SPECIFICATION.

2. NOTATIONS

ADDRESSES IN THE EMS BUFFER AND REGISTER ARE WRITTEN IN OCTAL NOTATION (INDICATED BY OCT), WHICH ARE AT PRESENT IMPLEMENTED IN THE RANGE 0000-0777 (OCT). THE ADDRESSING ALLOWS FOR A FUTURE EXPANSION TO 7777 (OCT). NOTE THAT EARLIER DOCUMENTATION ON EMS HAS USED THE HEXADECIMAL NOTATION WITH A,B,C,D,E,F FOR THE DIGITS TEN THROUGH FIFTEEN. THE FOLLOWING CONVERSION TABLE CAN BE USED IN THE RANGE 000-0FF (HEX):

HEXADECIMAL	OCTAL	HEXADECIMAL	OCTAL
000-00F (HEX)	0000-0017 (OCT)	080-08F (HEX)	0200-0217 (OCT)
010-01F	0020-0037	090-09F	0220-0237
020-02F	0040-0057	0A0-0AF	0240-0257
030-03F	0060-0077	0B0-0BF	0260-0277
040-04F	0100-0117		
		0C0-0CF	0300-0317
050-05F	0120-0137	0D0-0DF	0320-0337
060-06F	0140-0157	0E0-0EF	0340-0357
070-07F	0160-0177	0F0-0FF	0360-0377

FOR ADDRESSES IN THE RANGE 100-1FF(HEX), ADD 0400(OCT).

EACH CELL CAN STORE 6 BITS OF DATA. IN ACCORDANCE WITH EARLIER EMS DOCUMENTATION THE BITS ARE NUMBERED FROM RIGHT TO LEFT:

T5 T4 T3 T2 T1 T0

CORRESPONDING TO THE SIX LINES T5-T0 OF THE EMS DATA TRUNK. IN COMMUNICATION WITH MAGNETIC TAPES AND THE PDP-15, THIS MAKES T5 THE MOST SIGNIFICANT BIT AND T0 THE LEAST SIGNIFICANT BIT. A SINGLE BIT OF ONE CELL WILL BE WRITTEN BY PUTTING THE BIT DESIGNATION AFTER THE OCTAL ADDRESS, THUS 0123T5 DENOTES THE LEFTMOST BIT OF ADDRESS 0123(OCT). IN THIS CONNECTION, THE SUBSCRIPT 8 WILL BE OMITTED.

MOST DATA USE A MIXED DECIMAL-BINARY REPRESENTATION IN EMS, WHICH ALLOWS THE PARAMETERS TO BE SET OR DISPLAYED IN DECIMAL AT THE MANUAL CONSOLE. THIS DESCRIPTION USES THE FOLLOWING NOTATION TO REPRESENT THE SINGLE BITS OF A DECIMAL INTEGER:

D8,	D4,	D2,	D1	ONES DIGIT
D80;	D40,	D20,	D10	TENS DIGIT
D800,	D400,	D200,	D100	HUNDREDS DIGIT
D8000	D4000,	D2000,	D1000	THOUSANDS DIGIT

SINCE AMPLIFIER VALUES MAY BE SET TO QUARTERS OF DECIBELS, WE FURTHER USE D.50 AND D.25 TO DENOTE THE BITS FOR ONE-HALF AND ONE-QUARTER DECIBEL. THE CONTENTS OF A NUMBER ARE SIMPLY OBTAINED BY ADDING THE VALUES OF THOSE BITS WHICH ARE SET=1.

3. SOUND GENERATOR PARAMETERS

THERE ARE 24 SOUND GENERATORS DENOTED SG1-SG24. EACH SOUND GENERATOR IS DESCRIBED BY THREE PARAMETERS, NAMELY FREQUENCY, WAVE FORM AND AMPLITUDE. EACH FREQUENCY IS STORED IN 3 CONSECUTIVE CELLS, EACH WAVE FORM IN ONE AND EACH AMPLITUDE IN 2 CELLS. THE ADDRESSES OF THE SOUND GENERATOR PARAMETERS ARE CALCULATED FROM THE FOLLOWING EXPRESSIONS, WHERE K (=1-24) IS THE NUMBER OF THE SOUND GENERATOR:

FREQUENCY FROM 3*(K-1) TO 3*(K-1) + 2
WAVE FORM AT K+0107(OCT)
AMPLITUDE FROM 2*K+0136(OCT) TO 2*K+0137(OCT)

PERMITTED FREQUENCIES ARE IN THE RANGE 0 TO 15999 IN STEPS OF 1. VALUES ABOVE 9999 ARE REPRESENTED BY LETTING THE D8000, D4000, D2000 AND D1000 BITS YIELD ANY VALUE OF 0-15 THOUSANDS; THE HUNDREDS, TENS AND UNIT DIGITS SHOULD ONLY YIELD DIGITS 0-9 EACH. THE BITS ARE STORED AS FOLLOWS:

CELL/BIT	T5	T4	T3	T2	T1	T0		
			L			R		
3*(K-1)	D40	D80	D1	D2	D4	D8	AL	AR
3*(K-1)+1	D100	D200	D400	D800	D10	D20	BL	DR
3*(K-1)+2			D1000	D2000	D4000	D8000	CL	CR

PERMITTED WAVE FORMS ARE 0-7 IN STEPS OF 1, WHERE 0 AND 1 DENOTE THE SAME (SINUSOIDAL) WAVE FORM. THE BITS ARE STORED:

Vougeneratorfrekvenser

1000. tal

CL \ CR	0	1	2	3	4	5	6	7
0	0	8	4	12	2	10	6	14
1	1	9	5	13	3	11	7	15

100. tal

BL \ BR	0-3	4-7
0	0	8
1	4	–
2	2	–
3	6	–
4	1	9
5	5	–
6	3	–
7	7	–

10. tal

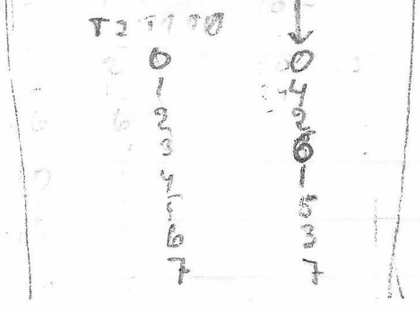
AL \ BR	0	1	2	3	4	5	6	7
0-1	0	2	1	3	0	2	1	3
2-3	8	–	9	–	8	–	9	–
4-5	4	6	5	7	4	6	5	7
6-7	–	–	–	–	–	–	–	–

1. tal

AL \ AR	0	1	2	3	4	5	6	7
0,2,4,6	0	8	4	–	2	–	6	–
1,3,5,7	1	9	5	–	3	–	7	–

KURVFORMER

T2 T1 T0



CELL/BIT	T5	T4	T3	T2	T1	T0
K+0107(0CT)	-	-	-	D1	D2	D4

PERMITTED AMPLITUDES ARE 0-120 DECIBEL IN STEPS OF 0,25. VALUES ABOVE 99 ARE REPRESENTED BY LETTING THE BITS D80, D40, D20, D10 YIELD ANY DIGIT BETWEEN 0 AND 12 TENS. THE BITS ARE STORED:

CELL/BIT	T5	T4	T3	T2	T1	T0
2*K+0136(OCT)	D2	D4	D8	D.25	D.50	-
2*K+0137(OCT)	-	D10	D20	D40	D80	D1

AL	AR
BL	BR

4. FILTER AMPLITUDES

THERE ARE TWO FILTER UNITS F1, F2 WITH 28 CHANNELS EACH. THE AMPLIFIER OF EACH INDIVIDUAL CHANNEL CAN BE SET TO ANY VALUE FROM 0-120 DECIBEL IN STEPS OF 0,25. EACH AMPLITUDE IS STORED IN TWO CONSECUTIVE CELLS, NAMELY

F1 CHANNEL K FROM 2*K+0216(OCT) TO 2*K+0217(OCT) (K=1-34(OCT)
F2 CHANNEL K FROM 2*K+0306(OCT) TO 2*K+0307(OCT)

NOTE THAT THE INTERNAL STORAGE OF FILTER CHANNEL AMPLITUDES DIFFERS FROM THAT OF OTHER AMPLIFIERS*

CELL/BIT	T5	T4	T3	T2	T1	T0
2*K+0216/0306(OCT)	D4	D8	D10	D20	D40	D80
2*K+0217/0307(OCT)	-	-	D.25	D.50	D1	D2

AL	AR
BL	BR

5. MISCELLANEOUS AMPLIFIERS

THE DEVICES BELOW HAVE ONE AMPLIFIER EACH, WHICH CAN BE SET TO 0-120 DECIBEL IN STEPS OF 0,25. THE ADDRESSING AND INTERNAL REPRESENTATION CORRESPONDS TO THOSE OF SOUND GENERATOR AMPLIFIERS (PARAGRAPH 3) IF WE ASSIGN THE FOLLOWING VALUES OF K:

REVERBERATION UNITS	RV1	K=81(DEC)
	RV2	K=82
NOISE GENERATOR	NG	K=83
ANALOG TAPE RECORDER	TR1	K=84
	TR2	K=85
	TR3	K=86
	TR4	K=87
RING MODULATORS	RM1	K=88
	RM2	K=89
	RM3	K=90
AMPLITUDE MODULATORS	AM1	K=91
	AM2	K=92
SINGLE AMPLIFIERS	AMP1	K=93
	AMP2	K=94

AMPLITUD

10. tal

BL \ BR	0-1	2-3	4-5	6-7
0	0	8	4	12
1	2	10	6	-
2	1	9	5	-
3	3	11	7	-

1. tal

AL \ BR	0,2,4,6	1,3,5,7
0	0	1
1	8	9
2	4	5
3	-	-
4	2	3
5	-	-
6	6	7
7	-	-

bakdel

AR	↓
0	0
2	.50
4	.25
6	.75

FILTER AMPLITUD

10. tal

AL \ AR	0	1	2	3	4	5	6	7
0,2,4,6	0	8	4	-	2	-	6	-
1,3,5,7	1	9	5	-	3	-	7	-

1. tal

AL \ BR	0	1	2	3	4	5	6	7
0-1	0	2	1	3	0	2	1	3
2-3	8	-	9	-	8	-	9	-
4-5	4	6	5	7	4	6	5	7
6-7	-	-	-	-	-	-	-	-

bakdel

BL \ BR	0-3	4-7
0	0	.50
1	.25	.75

POSITION SIMULATORS — PS1 K=95; PS2 K=96; PS3 K=97; PS4 K=98

OUTPUT CHANNELS — CH1 K=99; CH2 K=100; CH3 K=101; CH4 K=102

CELL/BIT	T5	T4	T3	T2	T1	T0
2**K+0136(OCT)	D2	D4	D8	D.25	D.50	-
2**K+0137(OCT)	-	D10	D20	D40	D80	D1

6. SWITCHBOARD CONNECTIONS

A NUMBER OF CELLS ARE OCCUPIED BY THE PROGRAMMABLE SWITCHBOARD. EACH BIT HAS THEN THE FUNCTION TO CONNECT (BIT=1) OR DISCONNECT (BIT=0) SOME DEVICE FROM SOME OTHER.

IN ADDITION TO THE SYMBOLS USED FOR MISCELLANEOUS AMPLIFIER OUTPUTS IN THE PREVIOUS SECTION, THE FOLLOWING SYMBOLS OCCUR IN THE CONNECTION TABLES:

SG3	COMMON OUTPUT OF SOUND GENERATORS 1-3
SG6	" " " " " 4-6
SG9	" " " " " 7-9
SG12	" " " " " 10-12
SG15	" " " " " 13-15
SG18	" " " " " 16-18
SG19-SG24	INDIVIDUAL SOUND GENERATOR OUTPUTS
SGBUS	COMMON SOUND GENERATOR BUS, LOCATED NEAR SG22 ON THE CONSOLE.
RM1A,RM1B,RM2A,RM2B	INPUTS OF RING MODULATORS 1-2
AM1A,AM1B,AM2A,AM2B	AND AMPLITUDE MODULATORS 1-2
PS5-PS8	POSITION SIMULATORS 5-8, AT PRESENT USED FOR ANALOG TAPE RECORDING
WHITE	WHITE NOISE GENERATOR OPTION
PINK	PINK NOISE GENERATOR OPTION
FRC	FREQUENCY CHANGER

THE TABLE ON PAGES 5-6 GIVE THE CONNECTION TABLE ORDERED BY ADDRESSES, AND PAGES 7-12 ORDERED BY DEVICE. IN THE LATTER TABLE, PERMANENT CONNECTIONS ARE DENOTED BY -P-.

THE CONNECTION TABLE ALSO STORES THE TIMING CONSTANTS OF THE REVERBERATION UNITS RV1 AND RV2. A TIMING CONSTANT IS STORED AS A FOUR BIT INTEGER K, WHICH CAN TAKE ANY VALUE FROM 1 TO 15. THE ACTUAL REVERBERATION TIME IS APPROXIMATELY

TIME = K*0.35 SECONDS

THE BITS OF K ARE STORED AS FOLLOWS:

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RV1   D1   0630T3          RV2   D1   0631T1
      D2   0630T2                D2   0631T0
      D4   0630T1                D3   0630T5
      D8   0630T0                D4   0630T4
.EJECT
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CELL/BIT	T5	T4	T3	T2	T1	T0
0520(OCT)	SG6>RM2B	SG6>RM1B	SG6>RM1A	SG6>F2	SG6>F1	SG3>PS1
521	SG12>F1	SG9>PS1	SG6>PS1	SG6>AM1B	SG6>RV2	SG6>RV1
522	SG12>RV2	SG12>RV1	SG12>RM2B	SG12>RM1B	SG12>RM1A	SG12>F2
523	SG18>RM1B	SG18>F2	SG18>F1	SG15>PS1	SG12>PS1	SG12>AM1B
524	SG18>PS1	SG18>AM2B	SG18>AM1B	SG18>RV2	SG18>RV1	SG18>RM2B
525	+SGBUS>RV1	+SGBUS>RM2B	+SGBUS>RM1B	+SGBUS>F2	+SGBUS>F1	+SG21>PS1
526	NG>CH1	+SGBUS>CH1	+SGBUS>PS1	+SGBUS>AM2B	+SGBUS>AM1B	+SGBUS>RV2
527	NG>PS1	NG>AM2B	NG>RV1	NG>RM2B	NG>F2	NG>F1
530	RV2>AM1B	RV1>PS1	RV1>AMP2	RV1>AMP1	RV1>AM2B	RV1>AM1B
531	F1>AM1A	F1>F2	RV2>PS1	RV2>AMP2	RV2>AMP1	RV2>AM2B
532	F1>AM2B	F1>AM1A	F1>RV2	F1>RV1	F1>RM2B	F1>RM1B
533	F2>RM2B	F2>RM1B	F2>F1~CH1	F1>PS1	F1>AMP2	F1>AMP1
534	F2>AMP2	F2>AMP1	F2>AM2A	F2>AM1B	F2>RV2	F2>RV1
535	AM2>CH1	AM1>CH1	TR1>RM1B	TR1>F2	TR1>F1	F2>PS1
536	TR1>PS5	TR1>AM2B	TR1>AM1B	TR1>RV2	TR1>RV1	TR1>RM2B
537	TR2>RV2	TR2>RV1	TR2>RM2B	TR2>RM1B	TR2>F2	TR2>F1
540	TR3>RM1B	TR3>F2	TR3>F1	TR2>PS6	TR2>AM2B	TR2>AM1B
541	TR3>PS7	TR3>AM2B	TR3>AM1B	TR3>RV2	TR3>RV1	TR3>RM2B
542	TR4>RV2	TR4>RV1	TR4>RM2B	TR4>RM1B	TR4>F2	TR4>F1
543	RM1>RV2	RM1>F2	RM1>F1	TR4>PS8	TR4>AM2B	TR4>AM1B
544	RV2>CH1	RV1>CH1	RM1>AMP2	RM1>AMP1	RM1>AM2B	RM1>AM1A
545	RM2>AM2A	RM2>AM1B	RM2>RV2	RM2>F2	RM2>F1	RM1>PS1
546	RM3>RV2	RM3>F2	RM3>F1	RM2>PS1	RM2>AMP2	RM2>AMP1
547	AM2>PS1	AM1>PS1	RM3>PS1	RM3>AMP2	RM3>AMP1	RM3>AM2B
550	AMP1>AM1B	AMP1>RV2	AMP1>RM2B	AMP1>RM1B	AMP1>F2	AMP1>F1
551	AMP2>RV2	AMP2>RM2B	AM2>RM1B	AMP2>F2	AMP2>F1	AMP1>AM2B
552	SG23>AM1A	SG22>RM2A	SG21>RM1A	SG20>FRC	AMP2>AM2B	AMP2>AM1B
553	RM2>CH1	RM1>CH1	SG9>SG12	SG6>SG9	SG3>SG6	SG24>AM2A
554	+SG19>SGBUS	SG21>SG19	SG20>SG19	SG18>SG19	SG15>SG18	SG12>SG15
555	SG9>CH4	SG6>CH4	SG3>CH4	+SG24>SGBUS	+SG23>SGBUS	+SG22>SGBUS
556	NG>CH4	+SGBUS>CH4	+SG21>CH4	SG18>CH4	SG15>CH4	SG12>CH4
557	RM2>CH4	RM1>CH4	RV2>CH4	RV1>CH4	AM2>CH4	AM1>CH4
560	SG9>CH3	SG6>CH3	SG3>CH3	F2>CH4	F1>CH4	RM3>CH4
561	NG>CH3	+SGBUS>CH3	+SG21>CH3	SG18>CH3	SG15>CH3	SG12>CH3
562	---	RM3>CH1	RV2>CH3	RV1>CH3	AM2>CH3	AM1>CH3
563	SG3>CH2	F2>CH3	F1>CH3	RM3>CH3	RM2>CH3	RM1>CH3
564	+SG21>CH2	SG18>CH2	SG15>CH2	SG12>CH2	SG9>CH2	SG6>CH2
565	RV2>CH2	RV1>CH2	AM2>CH2	AM1>CH2	NG>CH2	+SGBUS>CH2
566	SG3>CH1	F2>CH2	F1>CH2	RM3>CH2	RM2>CH2	RM1>CH2
567	+SG21>CH1	SG18>CH1	SG15>CH1	SG12>CH1	SG9>CH1	SG6>CH1
630	RV2>D4	RV2>D8	RV1>D1	RV1>D2	RV1>D4	RV1>D8
631	----	----	NG>WHITE	NG>PINK	RV2>D1	RV2>D2