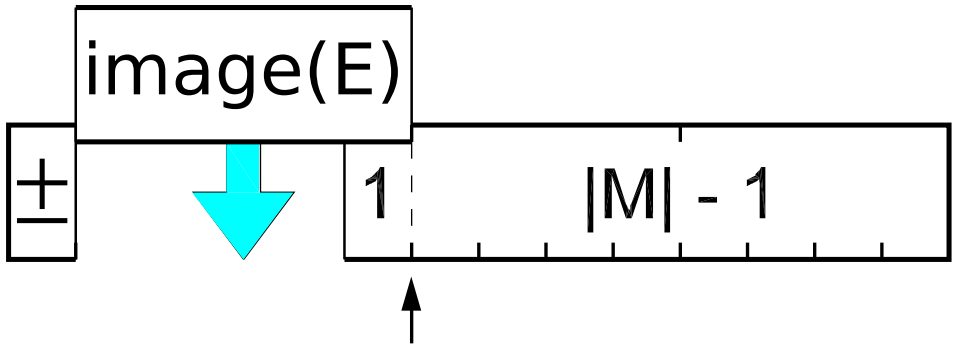
examples of G, R *and* S *bits usage*

assumed format:



- **Code used for exponent representation is not important (for these examples).**
- **Mantissa is in sign and magnitude code:**
  - **addition/subtraction of mantissa $\mapsto$ $\mapsto$ addition/subtraction of their absolute values,**
  - **multiplication/division of mantissa $\mapsto$ $\mapsto$ multiplication/division of their absolute values.**
- **The principle of hidden one is used.**
- **We assume, that division on individual parts is already processed:**
  sign, absolute value of mantissa and exponent.

addition

$$\mathbf{91{,}5 + 114{,}25 = 205{,}75 \doteq \begin{cases} 206 \\ 206 \end{cases}}$$

M	$G\,R\,S$	E	
1 0 1 1 0 1 1 1 0		**6**	operands
1 1 1 0 0 1 0 0 1		**6**	
0 1 0 1 1 0 1 1 1	**0 0 0**	**7**	correction
0 1 1 1 0 0 1 0 0	**1 0 0**	**7**	
1 1 0 0 1 1 0 1 1	**1 0 0**		addition of mantissa
1 1 0 0 1 1 0 1 1	**1 0 0**	**7**	standardization
1 1 0 0 1 1 1 0 0		**7**	rounding — pref. bigger number
1 1 0 0 1 1 1 0 0		**7**	rounding — pref. even digit

correction:

- conversion on same exponent (here without correction)
- shift to the right (eliminate overflow during addition of mantissa)

$$45{,}75 + 3{,}5625 = 49{,}3125 \doteq \begin{cases} 49{,}375 \\ 49{,}25 \end{cases}$$

M	$G\,R\,S$	E	
1 0110 1110		5	operands
1 1100 1000		1	
0 1011 0111	0 0 0	6	correction
0 0000 1110	0 1 0	6	
0 1100 0101	0 1 0		addition of mantissa
1 1000 1010	1 0 0	5	standardization
1 1000 1011		5	rounding — pref. bigger number
1 1000 1010		5	rounding — pref. even digit

$$\mathbf{366 + 28{,}5625 = 394{,}5625 \doteq \begin{cases} 395 \\ 395 \end{cases}}$$

M	$G\,R\,S$	E	
1 0 1 1 0 1 1 1 0		**8**	operands
1 1 1 0 0 1 0 0 1		**4**	
0 1 0 1 1 0 1 1 1	**0 0 0**	**9**	correction
0 0 0 0 0 1 1 1 0	**0 1 1**	**9**	
0 1 1 0 0 0 1 0 1	**0 1 1**		addition of mantissa
1 1 0 0 0 1 0 1 0	**1 1 0**	**8**	standardization
1 1 0 0 0 1 0 1 1		**8**	rounding — pref. bigger number
1 1 0 0 0 1 0 1 1		**8**	rounding — pref. even digit

$$\mathbf{182{,}5 + 0{,}28125 = 182{,}78125} \doteq \begin{cases} \mathbf{183} \\ \mathbf{183} \end{cases}$$

M	$G\,R\,S$	E	
1 0 1 1 0 1 1 0 1		**7**	operands
1 0 0 1 0 0 0 0		**-2**	
0 1 0 1 1 0 1 1 0	**1 0 0**	**8**	correction
0 0 0 0 0 0 0 0 0	**0 1 1**	**8**	
0 1 0 1 1 0 1 1 0	**1 1 1**		addition of mantissa
1 0 1 1 0 1 1 0 1	**1 1 0**	**7**	standardization
1 0 1 1 0 1 1 1 0		**7**	rounding — pref. bigger number
1 0 1 1 0 1 1 1 0		**7**	rounding — pref. even digit

subtraction

$$\mathbf{366 - 361 = 5 \doteq \begin{cases} 5 \\ 5 \end{cases}}$$

M	$G\,R\,S$	E	
1 0110 1110		**8**	operands
1 0110 1001		**8**	
1 0110 1110		**8**	1. operand
0 1001 0111		**8**	negation of 2. operand + ε
1 0110 1110	**0 0 0**	**8**	corrections — shifts and G,R,S
0 1001 0111	**0 0 0**	**8**	
0 0000 0101	**0 0 0**		subtraction of mantissa
1 0100 0000	**0 0 0**	**2**	standardization
1 0100 0000		**2**	rounding — pref. bigger number
1 0100 0000		**2**	rounding — pref. even digit

$$\mathbf{270 - 255{,}5 = 14{,}5 \doteq \begin{cases} 14{,}5 \\ 14{,}5 \end{cases}}$$

M	$G\,R\,S$	E	
1 0000 1110		**8**	operands
1 1111 1111		**7**	
1 0000 1110		**8**	1. operand
0 0000 0001		**7**	negation of 2. operand + ε
1 0000 1110	**0 0 0**	**8**	corrections — shifts and G,R,S
0 0000 0000	**1 0 0**	**8**	
0 0000 1110	**1 0 0**	**8**	subtraction of mantissa
1 1101 0000	**0 0 0**	**3**	standardization
1 1101 0000		**3**	rounding — pref. bigger number
1 1101 0000		**3**	rounding — pref. even digit

$$\mathbf{367 - 90{,}5 = 276{,}5 \doteq \begin{cases} 277 \\ 276 \end{cases}}$$

M	$G\,R\,S$	E	
1 0 1 1 0 1 1 1 1		**8**	operands
1 0 1 1 0 1 0 1 0		**6**	
1 0 1 1 0 1 1 1 1		**8**	1. operand
0 1 0 0 1 0 1 1 0		**6**	negation of 2. operand + ε
1 0 1 1 0 1 1 1 1	**0 0 0**	**8**	corrections — shifts and G,R,S
1 1 0 1 0 0 1 0 1	**1 0 0**	**8**	
1 0 0 0 1 0 1 0 0	**1 0 0**	**8**	subtraction of mantissa
1 0 0 0 1 0 1 0 0	**1 0 0**	**8**	standardization
1 0 0 0 1 0 1 0 1		**8**	rounding — pref. bigger number
1 0 0 0 1 0 1 0 0		**8**	rounding — pref. even digit

$$\mathbf{367 - 5{,}65625 = 361{,}34375 \doteq \begin{cases} 361 \\ 361 \end{cases}}$$

M	$G\,R\,S$	E	
1 0 1 1 0 1 1 1 1		**8**	operands
1 0 1 1 0 1 0 1 0		**2**	
1 0 1 1 0 1 1 1 1		**8**	1. operand
0 1 0 0 1 0 1 1 0		**2**	negation of 2. operand + ε
1 0 1 1 0 1 1 1 1	**0 0 0**	**8**	corrections — shifts G,R,S
1 1 1 1 1 0 1 0 0	**1 1**	**8**	
1 0 1 1 0 1 0 0 1	**0 1 1**	**8**	subtraction of mantissa
1 0 1 1 0 1 0 0 1	**0 1 1**	**8**	standardization
1 0 1 1 0 1 0 0 1		**8**	rounding — pref. bigger number
1 0 1 1 0 1 0 0 1		**8**	rounding — pref. even digit

multiplication

$$\mathbf{91{,}5 \cdot 228{,}5 = 20907{,}75} \doteq \begin{cases} \mathbf{20928} \\ \mathbf{20928} \end{cases}$$

M	$G\,R\,S$	E	
1 0110 1110		**6**	operands
1 1100 1001		**7**	
1 0110 1110	**0 0 0**	**6**	correction
0 1110 0100	**1 0 0**	**8**	
0101 0001 1010 1011 1100 0000			all bits of product
1 0100 0110	**1 0 1**	**14**	multiplication
1 0100 0110	**1 0 1**	**14**	standardization
1 0100 0111		**14**	pref. bigger number
1 0100 0111		**14**	pref. even digit

correction:

- ensuring that the intermediate result (i.e. multiplication)
- it should be always smaller than 2

$$\mathbf{78 \cdot 164 = 12792 \doteq \begin{cases} 12800 \\ 12800 \end{cases}}$$

M	$G\,R\,S$	E	
1 0011 1000		**6**	operands
1 0100 1000		**7**	
1 0011 1000	**0 0 0**	**6**	correction
0 1010 0100	**0 0 0**	**8**	
0011 0001 1111 1000 0000 0000			all bits of product
0 1100 0111	**1 1 1**	**14**	multiplication
1 1000 1111	**1 1 0**	**13**	standardization
1 1001 0000		**13**	pref. bigger number
1 1001 0000		**13**	pref. even digit

division

$$\mathbf{1 : 10 = 0{,}1} \doteq \begin{cases} \mathbf{0{,}100\,097\,656\,25} \\ \mathbf{0{,}100\,097\,656\,25} \end{cases}$$

M	$G\,R\,S$	E	
1 0000 0000		**0**	operands
1 0100 0000		**3**	
1 0000 0000	**0 0 0**	**0**	operands & G & R & S
1 0100 0000	**0 0 0**	**3**	
0 , 1100 1100 11	$\overline{0011}$		quotient
0 , 0000 0000 0000 1000 00			reminder
0 1100 1100	**1 1 1**	**-3**	quotient
1 1001 1001	**1 1 0**	**-4**	standardization
1 1001 1010		**-4**	pref. bigger number
1 1001 1010		**-4**	pref. even digit

note.: $\left.\begin{array}{l} \mathbf{0,5} \le a < \mathbf{1} \\ \mathbf{0,5} \le b < \mathbf{1} \end{array}\right\} \Rightarrow \quad \mathbf{0,5} < a/b < \mathbf{2}$