Simple Subroutines Example

Negative of Variable

```
Neg:    CMA
        INC
        RET
;================
Main:   LDA    X1
        CAL    Neg
        STA    X1
        LDA    X2
        CAL    Neg
        STA    X3
        HLT
;================
X1:     DEC    5
X2:     DEC    7
X3:     DEC    0
```

```
int AC;
int X1 = 5;
int X2 = 7;
int X3;
int Neg()
  {
    return(-AC);
  }
void main()
  {
    AC = X1;
    X1 = Neg();
    AC = X2;
    X3 = Neg();
  }
```

Subroutine's Parameters Example

```
int X1 = 5;
int X2 = 7;
int X3;
int Add(int x, int y)
  {
   return(x+y);
  }
void main()
  {
    X3 = Add(X1, X2);
  }
```

```
Add:    XAB
        PSH         } PUSH BP
        MAS           BP <= SP
        XAB
        LAB    2
        STA    BX
        LAB    3
        ADD    BX
        XAB
        POP         } POP BP
        XAB
        RET    2
;================
Main:   LDA    X1
        PSH
        LDA    X2
        PSH
        CAL    Add
        STA    X3
        HLT
;================
BX:     DEC    0
CX:     DEC    0
DX:     DEC    0

X1:     DEC    5
X2:     DEC    7
X3:     DEC    0
```

Variable pass by reference (Pointer)

```
int X1 = 5;
int X2 = 7;

void Ref(int x, int *y)
  {
   x=0; (*y)=0;
  }
void main()
  {
   Ref(X1, &X2);
  }
```
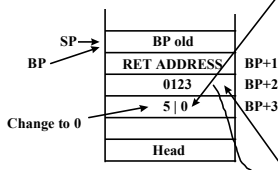
```
Ref:    XAB
        PSH         } PUSH BP
        MAS           BP <= SP
        XAB
        LLI    0
        SAB    3
        LAB    2
        STA    BX
        LLI    0
        STA    [BX]
        XAB
        POP         } POP BP
        XAB
        RET    2
;================
Main:   LDA    X1
        PSH
        LLI    X2
        LHI    X2
        PSH
        CAL    Ref
        HLT
;================
BX:     DEC    0
CX:     DEC    0
DX:     DEC    0

X1:     DEC    5
X2:     DEC    7
X3:     DEC    0
```

```
SP →   | BP old       |
BP →   | RET ADDRESS  | BP+1
       | 0123         | BP+2
       | 5 | 0        | BP+3
Change to 0
       | Head         |
High Address           0122H
                       0123H
```

No Change
Change to 0

Loop Example (Shl n)

```
int X1 = 5;
int X2 = 0;

void Shl(int x, int n)
 {
  return(x << n);
 }
void main()
 {
  X2 = Shl(X1, 4);
 }
```

```
       SP →  |   BP old      |
       BP →  | RET ADDRESS   | BP+1
             |      4        | BP+2
       X1 →  |      5        | BP+3
             |    Head       |
High Address
```

```
Shl:  XAB            }  PUSH BP
      PSH               BP <= SP
      MAS
      XAB
      LAB    2       }  BX = -n
      CMA
      INC
      STA    BX
      LAB    3
lp1:  CLE
      CIL
      ISZ    BX
      JMP    lp1
      XAB            }  POP BP
      POP
      XAB
      RET    2
;================
Main: LDA    X1
      PSH
      LLI    4
      PSH
      CAL    Shl
      STA    X2
      HLT
;================
BX:   DEC    0

X1:   DEC    5
X2:   DEC    0
```
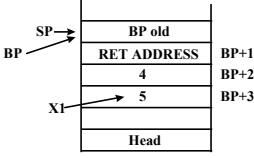
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Local Variable Example

```
int X1 = 5; int X2 = 7; int X3;
int Bum(int x, int y)
 {
  int t;
  t = x + y;
  if (t==y)
    return(t);
  else
    return(0);
 }
void main()
 { X3 = Bum(X1, X2); }
```

```
Main:  LDA    X1
       PSH
       LDA    X2
       PSH
       CAL    Bum
       STA    X3
       HLT
;================
BX:    DEC    0

X1:    DEC    5
X2:    DEC    7
X3:    DEC    0
```

```
Bum:  XAB           }  PUSH BP
      PSH              BP <= SP
      MAS
      XAB
      LLI    -1      }  SP <= SP-1
      STA    BX
      MAS
      ADD    BX
      MSA
      LAB    2       }  AC = X + Y
      STA    BX
      LAB    3
      ADD    BX
      SAB    -1      }  t = AC
      STA    BX
      LAB    3       }  AC = t - Y
      CMA
      INC
      ADD    BX
      SZA            }  If (AC == 0)
      JMP    NZ         AC = t
      LAB    -1
NZ:   XAB            }  SP <= BP
      MSA              POP BP
      POP
      XAB
      RET    2
```

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Recursion (Sum of Series)

```
int X1 = 3; int X3;
int Sum(int x)
 {
  int t = 0;
  if (x==0)
    return(0);
  else {
     t = x + Sum(x-1);
     return(t);
     }
 }
void main()
 { X3 = Sum(X1); }
```

```
Main:  LDA    X1
       PSH
       CAL    Sum
       STA    X3
       HLT
;================
BX:    DEC    0
X1:    DEC    3
X3:    DEC    0
```

```
Sum:  XAB           }  PUSH BP
      PSH              BP <= SP
      MAS
      XAB
      LLI    -1      }  SP <= SP-1
      STA    BX
      MAS
      ADD    BX
      MSA
      LAB    2       }  If (x==0)
      SNZ              return(0)
      JMP    sof
      SAB    -1      }  t = x
      DER
      PSH
      CAL    Sum     }  BX=Sum(x-1)
      STA    BX
      LAB    -1      }  AC = x + BX
      ADD    BX
sof:  XAB           }  SP <= BP
      MSA              POP BP
      POP
      XAB
      RET    1
```

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