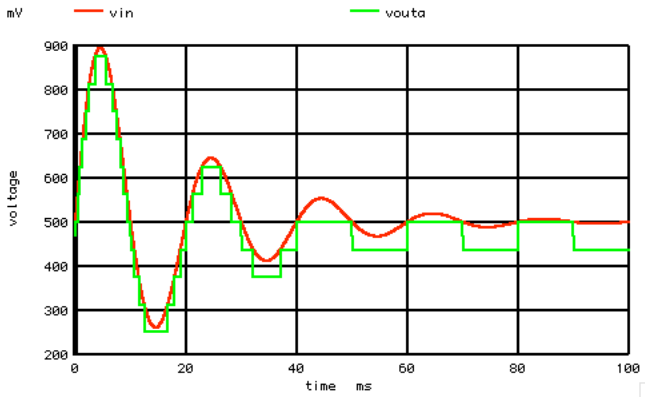
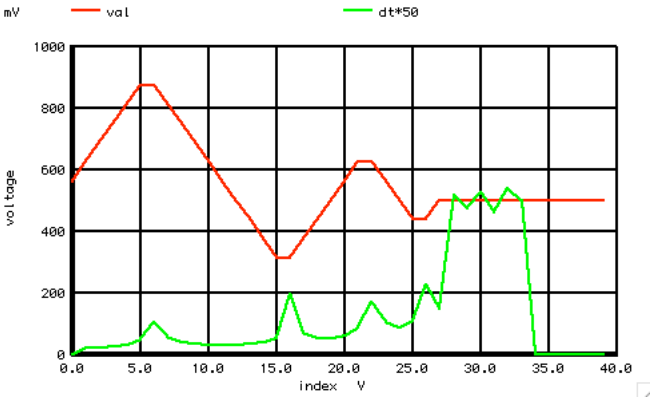
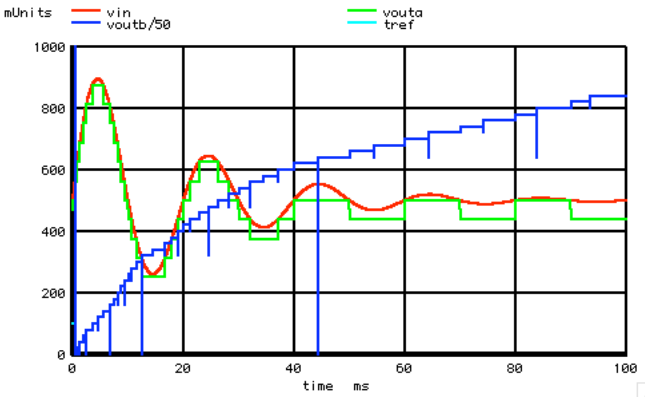
==========When_to_sample?==========

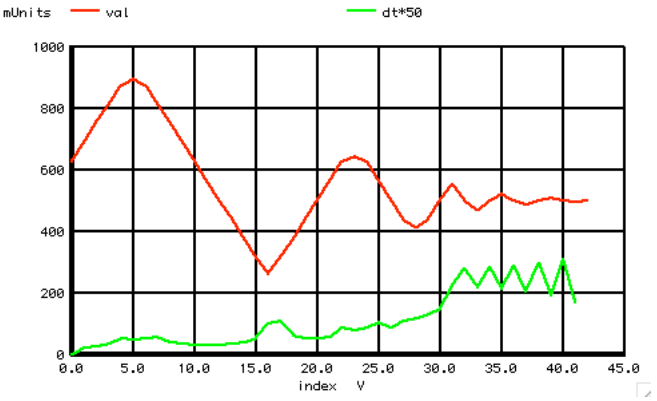
The idea is to sample when something happens.
So when is something happening?



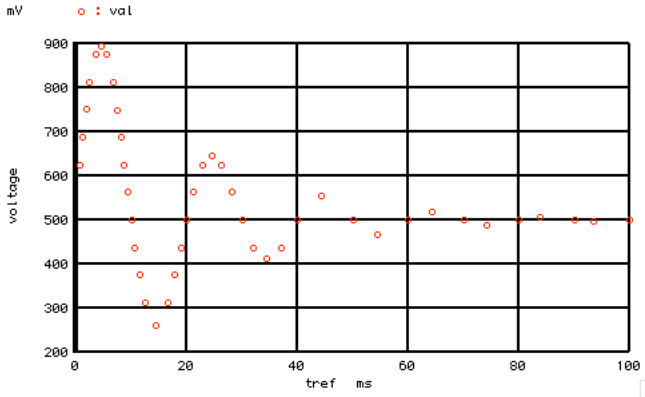


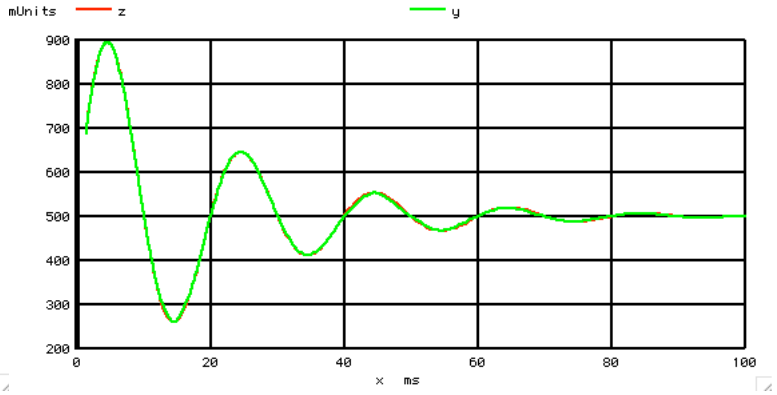
Threshold crossing might lose information when the input signal becomes small.
There is no reason why the sample thresholds need to be uniformly spaced voltage wise.





This example triggers additionally off of the waveform's minimums and maximums.
Spice uses a type of sampling that look like it responds more to waveform acceleration.





For the last three waveform cycles above,
notices that only zero crossings and max and min data points are sampled.
That averages to about four crossing points per cycle.
And still the extrapolated curve in green comes close to the real input in red.
So the trade off between number of sample points and signal integrity is not obvious.

Remember for Asynchronous Analog to Digital Conversion,
the sampling is done only when something is happening.
And the input signal is sampled at a precise value,
at a precise time.
So how well does it capture a waveform?

========Spice_Code====================================

```
Extrapolate_Decaying_Sinewave
*
**
*       VIN
*
*      ________________    __________
*    _|_      |  TH0   _|_ |  TH1   _|_  |  TH0
*   /_  \     |       _/   \ |     _/   \ |
*  //\  \    |\   |  \___/ |\   |  \___/ ||\        ____________
*  \  \//   |_| \_|    |___|_| \_|    |___|_| \_            \
*   \___/       /  |  OFF0    /  |  OFF1     /  |     ____  DAC    \__|VOUTA|
*    _|_       |/   |        |/   |          |/   |     |         /   |_____|
*    ///            |             |               |    |         /
*               |D0 |         |D1 |          |D2 |__|   __|_____/
*               |___|         |___|          |___|     |
*                 |              |_________________|   |
*                 |____________________________________|
*


*=========Create_Signal==================
*V_SIN#   NODE_P NODE_N DC     VALUE  SIN(   V_DC   AC_MAG FREQ   DELAY  FDamp)
VIN       VSIN   0      DC     0      SIN(   0      .5     50            )
Vtime     Vtime  0      DC     0      PWL( 0 0 1 1)
Bgain     Vgain  0      V =    exp(-V(Vtime)/.02)
BVIN      VIN    0      V =    V(VSIN)*V(Vgain) +.5

*=========AADC==============================
BTH0      D0     0      V =    u( V(VIN)  -1/2)
BOFF0     VIN    OFF0   V =    V(D0)/2
BTH1      D1     0      V =    u( V(OFF0) -1/4)
BOFF1     OFF0   OFF1   V =    V(D1)/4
BTH2      D2     0      V =    u( V(OFF1) -1/8)
BOFF2     OFF1   OFF2   V =    V(D2)/8
BTH3      D3     0      V =    u( V(OFF2) -1/16)
BOFF3     OFF2   OFF3   V =    V(D3)/16
BTH4      D4     0      V =    u( V(OFF3) -1/32)
BDAC      VOUTA  0      V =    (V(D0)/2+V(D1)/4+V(D2)/8 +V(D3)/16)
*=========Counter_Trigger==============================
CHP       VOUTA  HP     .1n
RHP       HP     0      100K
CHP2      VIN    HP2    .1n
RHP2      HP2    0      100K
BTRIG2    trig2  0      V = u( 100*abs(V(HP))  -.1   )+u(.005m - abs(V(hp2)) )
*=========Counter==============================
Btrig     trig   0      V =    1*u( V(VOUTA)- V(VIN) +5m )
XTOGLE    trig2  D0B    TOGLE
XTOGLE0   D0B    D1B    TOGLE
XTOGLE1   D1B    D2B    TOGLE
XTOGLE2   D2B    D3B    TOGLE
XTOGLE3   D3B    D4B    TOGLE
XTOGLE4   D4B    D5B    TOGLE
BDAC2     VOUTB  0      V =    63-(V(D5B)*32+V(D4B)*16+V(D3B)*8+V(D2B)*4 +V(D1B)*2 +V(D0B))

XPOS_E2   trig2  PEOUT   POS_E2
XS_H1     Vtime  trig   VtimeS      SH

.control
*TRAN     TSTEP  TSTOP  TSTART TMAX   ?UIC?
tran      2u    100m      0      2u
*=========Value_And_Time==============================
set       pensize = 2
let       numb = length(vtimes)-1001
unlet     index
unlet     val
unlet     tref
let index = vector(43)*0 +42
let val   = vector(43)*0 +.5
let tref  = vector(43)*0 +.1
let dt    = vector(43)*0
plot        vin  vouta   voutb/50 xlimit  1m  100m


*=========Reduce_Number_Of_Points==============================
let i     = 1000
repeat    $&numb
let tt    = peout[i]

if        (tt > .1)
let k     = voutb[i]
let       index[k] = k
let       value = vin[i]
let       val[k] = value
let       tref[k] = time[i]
end
let i     = i+1
end

let i     = 1
repeat    41
let dt[i] = tref[i] -tref[i-1]
let i     = i+1
end

plot val  tref*10  vs index
plot val           vs tref pointplot

*=========Curvefit_Points==============================
```

```
unlet  x
unlet  indext
unlet  indexn
let x      = vector(430)*0 +.1
let indext = vector(430)
let indexn = vector(430)*0
let y      = vector(430)*0 +.5
let z      = vector(430)*0 +.5

let i = 0
let j = 1
let n = 0
repeat  40
let S0  = val[j  ]-val[j-1]
let S1  = val[j+1]-val[j  ]
let S2  = val[j+2]-val[j+1]
let S01 = (S1+S0)/2
let S12 = (S2+S1)/2
let HH  = val[j+1]-val[j]
let A   = val[j]
let B   = S01
let C   =  3*HH -2*S01 -S12
let D   = -2*HH   +S01 +S12

repeat  10
let indext[i] = i
let x[i] = tref[j] +  n*(tref[j+1]-tref[j])/10
let tt = n/10
let indexn[i] = n/10
let y[i] =  A  +B*tt  +C*tt^2 +D*tt^3
let z[i] =  .5*sin( 360*50*x[i] )*exp(-x[i]/.02) +.5
let n = n + 1
let i = i + 1
end
let n = 0
let j = j + 1
end


plot z vs x
plot z y     vs x

.endc

.MODEL    SW      SW(    VT=.5 VH=.1  RON=1 ROFF=100MEG)
.MODEL    DD2      D( IS=3.15e-18 RS=1  CJ0=2f)

*=========POS_Edge2============================================
*
*   ___    |\              VBF ____            ___
* |IN |__|3\_________________|    \ ___  ___  |   \ ___
* |___|    | / |            VLP| PE \_|OUT| |IN |_|PE \_|OUT|
*          |/  |/\  /\  /\____|     / |___| |___| |   / |___|
*                 \/  \/    | |___/              |__/
*               RLP        _|_
*                          ___
*                   CLP     |
*                          _|_
*                          ///
*
.SUBCKT   POS_E2  IN    OUT
 BBUF     VBF    0      V =   2*u( v(IN )-.5 )
 RLP      VBF    VLP    10k
 CLP      VLP    0      .1n   IC=0
 BAND     OUT    0      V =   u( u(v(VBF )-.5)*u(.5 -v(VLP ) ) -.1)
.ENDS     POS_E2

*=========Sample_Hold============================================
*
*            IN2
*     ___  |\    /          IN3 |\      ___
*   |IN |_|1\__/  ___________|2\____|OUT|
*   |___|  | / S1    _|_        | /    |___|
*          |/        ___        |/
*                C1   |
*                     |
*                    _|_
*                    ///
.SUBCKT   SH     IN     CNTL      OUT
 B1       IN2    0      V =       v(IN )
 S1       IN2    IN3    CNTL     0    SW
 C1       IN3    0      .1u

 R1       IN3    0      100Meg
 B2       OUT    0      V =       v(IN3 )
.ENDS     SH

*=========POS_Edge=============================================
*
*   ___    |\              VBF ____            ___
* |IN |__|3\_________________|    \ ___  ___  |   \ ___
* |___|    | / |            VLP| PE \_|OUT| |IN |_|PE \_|OUT|
*          |/  |/\  /\  /\____|     / |___| |___| |   / |___|
*                 \/  \/    | |___/              |__/
*               RLP        _|_
*                          ___
*                   CLP     |
*                          _|_
*                          ///
*
.SUBCKT   POS_E  IN     OUT
 BBUF     VBF    0      V =   u( v(IN )-.5 )
```

```
 RLP      VBF    VLP    10k
 CLP      VLP    0      .1n   IC=0
 BAND     OUT    0      V =    u( u(v(VBF )-.5)*u(.5 -v(VLP ) ) -.1)
.ENDS     POS_E

*=========TOGGLE============================================
*        _____________________________________
*       |                                     |
*       |   /    VC1 |\  _NVC1 /    VC2  |\   |  ___
*       |__/  _______| \/ \___/  ________| \__|_|OUT|
*          S1    _|_  | /\_/  S2   _|_    | /    |___|
*               ___   |/           ___    |/
*             C1 |               C2 |
*                |                 |
*               _|_               _|_
*               ///               ///                 |\
*  ___   |\             VBF ____               DPE   __|B\__\S2
* |IN |__|3\________________|   \ PE                |  | /  /
* |___|  | /|           VLP| PE \___/\  /\  /\_____|  |/
*        |/  |/\  /\  /\____|   /  \/  \/   |   |
*               \/  \/   |  |___/      RLP2    _|_   |  |\
*               RLP1    _|_                  ___   |__|M\__\S1
*                       ___             CLP2 |      | /  /
*                   CLP1 |                  _|_     |/
*                       _|_                 ///
*                       ///
.SUBCKT   TOGLE   IN     OUT2
 BBUF     VBF     0      V =    u( v(IN )-.5 )
 RLP      VBF     VLP    1k
 CLP      VLP     0      5n
 BAND     VPE     0      V =    u( u(v(VBF )-.5)*u(.5 -v(VLP ) ) -.5)
 RLP2     VPE     VLP2   .3k
 CLP2     VLP2    0      2n
 BBRK     BRK     0      V =     1-u(v(VLP2 )-.2)
 BMAK     MAK     0      V =     u(v(VLP2 )-.9)
 S1       OUT     VC1    MAK     0        SW
 S2       NVC1    VC2    BRK     0        SW
 C1       VC1     0      10n
 C2       VC2     0      10n
 R1       VC1     0      10Meg
 R2       VC2     0      10Meg
 BINV     NVC1    0      V =     1-u(v(VC1)-.2)
 BOUT     OUT     0      V =     u(v(VC2)-.2)
 BOUT2    OUT2    0      V =     1- u(v(VC2)-.2)
.ENDS     TOGLE

.end
```

8.18.11_4.09PM

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