DSP Development Environment: Introductory Exercise for TI TMS320C54x (Chinese Version)*

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Based on *DSP Development Environment: Introductory Exercise for TI TMS320C54x*† by

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Abstract

This exercise introduces the hardware and software used in the course. By the end of this module, you should be comfortable with the basics of testing a simple real-time DSP system with Code Composer Studio, the debugging environment we will be using throughout the semester. First you will connect the

*Version 1.3: Jun 3, 2009 3:36 pm GMT-5
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laboratory equipment and test a real-time DSP system with provided code to implement an eight-tap (eight coefficient) finite impulse response (FIR) filter. With a working system available, you will then begin to explore the debugging software used for downloading, modifying, and testing your code. Finally, you will create a filter in MATLAB and use test vectors to verify the DSP's output.

1

[U+7EC3] [U+4E60] [U+7ECD] [U+6D4B] [U+8BD5] E [U+7B80] [U+5355] ADSPB [U+7EDF] XAbΠ [U+8F6F] bΘ [U+4F60] l [U+8BFE

2 [U+5B9E] [U+9A8C] ˇ [U+5907]

[U+7EC3] [U+4E60] ˆ [U+5B9E] [U+9A8C] Πˇ [U+5907] 4ˇlSpectrum Digital TMS320LC54xßuATexas Instruments TMS320C549Wˇ [U+5904] '?ΘF [U+8BE5] DSPßH [U+8FDE] AR(PC)XWindows–B [U+7EDF] Code Composer Studio [U+4E3A] [U+6D4B] [U+8BD5] [U+5F00] [U+53D1] [U+73AF] Θ [U+6BCF] EDSPßH [U+9876] ΛASpectrum Digital"X [U+5757] 'XCrystal Semiconductor CS4226– [U+4E3A] [U+7F16] [U+7801] HΘ [U+8BE5] ßu, [U+4E24] E [U+62DF] [U+8F93 kHzACDX [U+9891] ' [U+6837] Θ [U+8BE5] DSPßu [U+8FD8] aΠ [U+8FC7] ffΛFX [U+6237] 1R [U+7EC8] [U+4EFF] " 1Πˇ Θ

DSPßHΠR, [U+6BCF] E [U+5B9E] [U+9A8C] Π [U+8FD8] [U+5E94] ˇ [U+5907] ˇ [U+53D1] yHX [U+4EA7] y [U+6D4B] [U+8BD5] ˇ

2.1 [U+6B65] [U+9AA4] 1: [U+8FDE] [U+7EBF]

XBNC [U+7535] [U+7F06] ˚ ˇ [U+53D1] yHA [U+8F93] wFDSPßuA [U+8F93] Π1Ψ [U+8FDE] Θ ˚ ßuA [U+8F93] wΠ1Π2FœHΨ [U+ (b [U+8FDE])Θ.

b[U+8FDE]

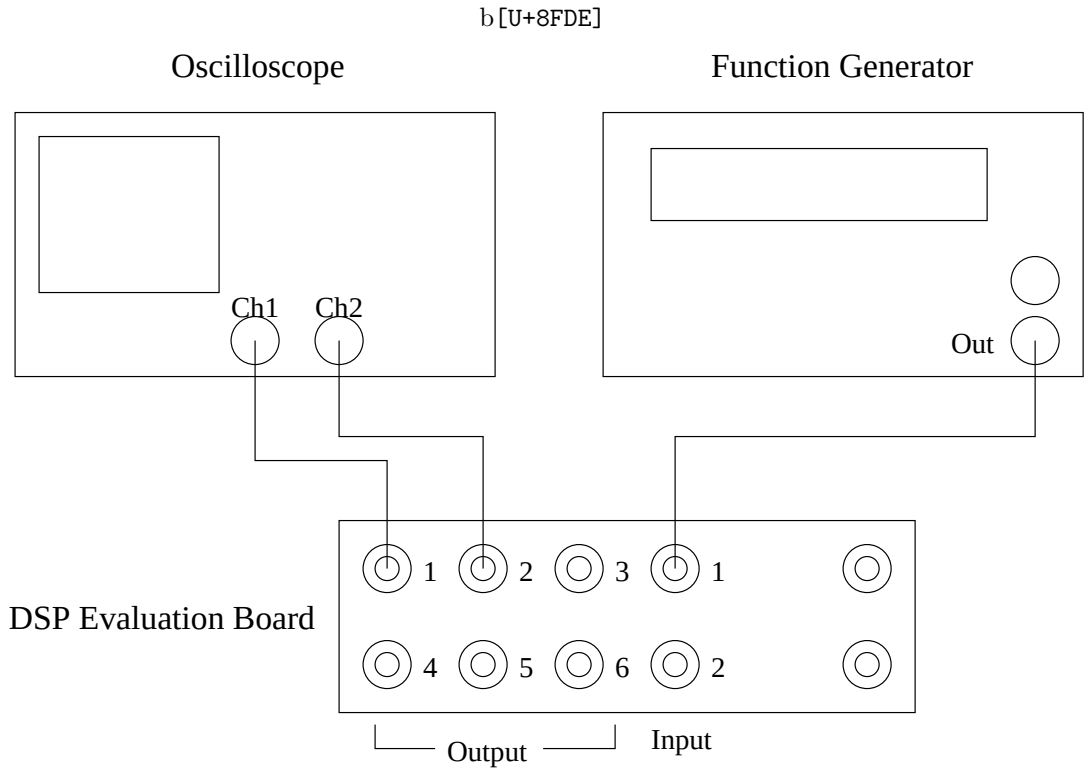

Figure 1

[U+8FD9][U+79CD]j[U+8FDE][U+7EBF]–4ȷ˘[U+8FDB]DSP,[U+4E24]ȷ˘[DSPwoΘΠ1woAh[U+6EE4]œA[U+8F93]ȷ˘,Π2woA

2.2 [U+6B65][U+9AA4]2: g[U+5F55]

X,A[[U+7EDC][U+5E10]˘Π[U+7801]g[U+5F55][U+8FDB][U+5B9E][U+9A8C]–ARΘ

3 [U+5F00][U+53D1][U+73AF]

[U+8BE5]DSPßuh:RΠ[U+8FC7]JTAG(XDS510PP)XCode Composer StudiojAΘ.[U+5F00][U+53D1][U+73AF][U+8BB8]X[U+6
(Section 3.1: [U+6B65][U+9AA4]3:[U+6C47][U+7F16][U+6EE4]œH1b[U+7801])),Π[U+8FC7]YoAMATLAB[U+7EC3][U+4E60
6Δ7 (Section 3.4: [U+6B65][U+9AA4]6:lMATLAB[U+68C0][U+9A8C][U+6EE4]œHA[U+9891][U+54CD][U+5E94]))Θ

3.1 [U+6B65][U+9AA4]3:[U+6C47][U+7F16][U+6EE4]œH1b[U+7801]

l[U+6267]ΛΠ[U+6D4B][U+8BD5],AFIR[U+6EE4]œH1b[U+7801],[U+4F60][U+987B]Ψo%bA[U+6C47][U+7F16]Θ¡,D[U+5F00
coef1.asm[2], coef2.asm[3], core.asm[4], Π vectcore.asm[5] ¸[U+8D1D][U+4F60]AΠ[U+5F55]Θ

[1] See the file at <http://cnx.org/content/m11893/latest/filter.asm>
[2] See the file at <http://cnx.org/content/m11893/latest/coef1.asm>
[3] See the file at <http://cnx.org/content/m11893/latest/coef2.asm>
[4] See the file at <http://cnx.org/content/m11893/latest/core.asm>
[5] See the file at <http://cnx.org/content/m11893/latest/vectcore.asm>

Yo, ¸[U+8D1D] [U+4EFD] coef1.asm[U+4E3A]“coef.asm”Π[U+8FC7] lDOSt[U+952E] asm filtero[U+6C47] [U+7F16] [U+6EE4

3.2 [U+6B65] [U+9AA4] 4: [U+9A8C] [U+6EE4] œH1

[U+6C47] [U+7F16] Ψ [U+6EE4] œH1b [U+7801], [U+51FB] Code Compose [U+56FE] [U+6807] [U+8FDB] 1 [U+8C03] [U+8BD5] [U+
mode status register (PMST, [U+5904] H [U+6001] L5H) Θ[Code ComposerADebugg [U+5355] [U+9009] [U+62E9] Reseto [U-
ßul [U+542F], [Viewg [U+5355] [U+9009] [U+62E9] CPU RegistersoD [U+5F00] [U+663E] DSPL5HW [U+503C] At, [U+8BE5] t
ComposertA%ΛΘPMSTL5HΘW [U+987B] [U+8BBE] od [U+8FDB] jAW [U+503C] FFE0 [U+786E] JDSPßuv–Θi [U+53D1] [U+73B0] [
RegistertΨ [U+5E94] AKΘ

[U+73B0] l, [U+9009] [U+62E9] Fileg [U+5355] ALoad Programo [U+8F7D] [U+6EE4] œH1A [U+6C47] [U+7F16] b [U+7801] Θ

[U+8FD0] Λ1A [U+8F93] [U+503C] o [U+8F93] Π1 (input channel 1), [U+7ECF] [U+8FC7] [U+6EE4] œAJ˘Π [U+8F93] J˘ß [U+522
channel 1 and 2) Θ:SW/W [U+8F6C] [U+6362] [U+8FC7] 1AΛ”,: [U+8F93] wΠ2¯wAJ˘aıΠ: [U+8F93] Π1 [U+8FDB] AJ˘ΨΨΘ [U+8BE
aliasing) [U+6EE4] œHΠœ (**anti-imaging**) [U+6EE4] œHΘ [U+8F6C] [U+6362] Hh [U+8FDE] [U+8026] ¯ (**AC cou-**
pled) A¸J˘ (lΠ [U+8FC7] Θl [U+8FD9] [U+79CD] Y, [U+4F60] [U+8BA4] [U+4E3A] [U+8F93] Π1Π [U+8F93] wΠ2Ω [U+95F4] 4a [U+4E4

˚J˘ [U+53D1] yHAcc [U+503C] [U+8BBE] o1.0V, œ4 [U+8BBE] ovœΘl#Ω [U+56F4] [U+53D8] [U+6EE4] œHA [U+8F93] [U+9891]
kHzA‘ [U+6837] Y, DSPB [U+7EDF] A [U+9891] [U+54CD] [U+5E94] Ω [U+56F4] [U+5E94] h¡d?

9[[U+4F60] [U+89C2] A [U+9891] [U+54CD] [U+5E94] [U+786E] # [U+6EE4] œHA [U+7C7B] 2(øΠΔJΠ [U+5E26] Π) [U+786E] #
6dB (oJ) [U+9891] Θ [U+8FD9] l [U+8FDB] ΛœHΠ2Aff [U+53D1] [U+8BBE] [U+65F6] aı4X, [U+4E3A] Π1AJ˘aıhΘ

3.3 [U+6B65] [U+9AA4] 5: [U+6C47] [U+7F16] Π [U+8FD0] ΛæA [U+6EE4] œH1

l [U+786E] #DSP [U+5B9E] [U+73B0] A [U+6EE4] œHA [U+7C7B] 2Ω, [U+4F60] IaΠ [U+8FC7] l [U+6C47] [U+7F16] [U+8FC7] 1XAW

[U+73B0] l [U+4F60] a [U+6C47] [U+7F16] [U+6D4B] [U+8BD5] [U+8FD9] EæA [U+6EE4] œH1, œl [U+6B65] [U+9AA4] 4
(Section 3.2: [U+6B65] [U+9AA4] 4: [U+9A8C] [U+6EE4] œH1) [U+6837] DOStA [U+6C47] [U+7F16] [U+6B65] [U+9AA4] o [U+6267]

F [U+6B65] [U+9AA4] 4 (Section 3.2: [U+6B65] [U+9AA4] 4: [U+9A8C] [U+6EE4] œH1) [U+7C7B], Π [U+8FC7] lA [U+9891] Y [U+
6dB [U+9891] Θ

3.4 [U+6B65] [U+9AA4] 6: l**MATLAB** [U+68C0] [U+9A8C] [U+6EE4] œHA [U+9891] [U+54CD] [U+5E94]

l [U+6B65] [U+9AA4], [U+4F60] Π [U+8FC7] [U+6EE4] œHW[DSP ¸[U+8D1D] MATLABXfreqz [U+663E] 3 [U+9891] [U+54CD] [U+

%bcoef.asmˆ7AFIR [U+6EE4] œHWilS0x1000 (d [U+8FDB] j) ADSP5Θ [U+4F60] [U+6C47] [U+7F16] Π [U+8FD0] ΛA [U+6BCF]
Window Optionsto [U+67E5] ˜XWAqWW [U+503C] Θf [U+8BBE] [U+4E3A] 0x1000, [U+8BBE] [U+4E3A] 16-Bit Signed
IntΘW [U+51FB] “OK”EaD [U+5F00] [U+663E] #5W [U+503C] AtΘE [U+4FA7] AW [U+503C] [U+663E] Ah5Θ

l [U+8FD9] E, [U+6EE4] œHWl5ffi&Θ%W h [7]S 0x1000 W h [0]S0x1007Θ

[U+73B0] l [U+4F60] [U+7ECF] l5WAW [U+503C], YoIaXMATLAB Afreqzo [U+663E] [U+6EE4] œHA [U+9891] [U+54CD] [U+5
-10, 20, -10 AW [U+6EE4] œHA [U+9891] [U+54CD] [U+5E94], [U+4EEC] alMATLABXY:

- h = [-10, 20, -10];
- plot(abs(freqz(h)))

[U+4F60] S50x10000x1007A]EW [U+503C] 3 [U+52A8] [U+8F93] WßhΘ

[U+89C2] MATLAB [U+663E] A [U+9891] [U+54CD] [U+5E94] Π [U+4F60] A [U+5B9E] [U+9A8C] [U+7ED3] i4“ [U+5F02] ?!o [U+

3.5 [U+6B65] [U+9AA4] 7: l**MATLAB** [U+4EA7] yΠ [U+68C0] [U+9A8C] æA [U+6EE4] œH

[U+5B9E] [U+9A8C] Π, @MATLABb [U+7801] o [U+5E2E] [U+4F60] [U+7F16] 1Θ3AE1 [U+4F60] alMATLAB [U+4EA7] yA [U+6EE

¡, lMATLAB [U+952E] h = gen_filt; o [U+4EA7] yERRA]W [U+6EE4] œHΘ [U+952E] save_coef('coef.asm', flipud(h))
Π save_coef.m[7] Θ)

MATLAB1Wßh5o#A%b(l [U+8FD9] hcoef.asm)ΘlJ5Ω [U+8FD9] @W“ [U+8F6C]”W [U+4EEC] t5 [U+8D2E] l[0x10000x1007A

[U+73B0] l [U+4F60] a [U+6B65] [U+9AA4] 5 (Section 3.3: [U+6B65] [U+9AA4] 5: [U+6C47] [U+7F16] Π [U+8FD0] ΛæA [U+6EE4

l [U+8F7D] æA [U+6EE4] œH1 [U+65F6] 50x10000x1007AM–Ψ [U+5E94] AæΘ

[6] See the file at <http://cnx.org/content/m11893/latest/gen_filt.m>
[7] See the file at <http://cnx.org/content/m11893/latest/save_coef.m>

3.6 [U+6B65] [U+9AA4] 8: l5 [U+8C03] q [U+6EE4] œHW

¨X [U+8C03] [U+8BD5] Σ˝a [U+67E5] ˊDSP5AW [U+503C], [U+8FD8] a [U+5BF9] “AM–K,–D [U+51FB] 5l [U+5F39] wAt–Ψ [U+5E94
K0x10000x10075AW [U+503C] 3XS [U+5B9E] [U+73B0] Ea [U+7EBF] n [U+53D8] [U+8F93] ˇd [U+4EA7] y#=A [U+6EE4] œH:

$$h[n] = 8192\delta(n-4) \tag{1}$$

DSPqW819232,768(d [U+8FDB] jL5Haı5 [U+8D2E] ATdqW)oyoEßWΘ. [U+8F93] w [U+7ED3] i# [U+8FDF] E‘ [U+6837] WLBW1/
Complement and Fractional Arithmetic for 16-bit Processors[8]Θ
KΨ4]EW, [U+8FD0] ΛæA [U+6EE4] œH1XœH [U+6D4B] [U+8F93] œ4Π [U+8F93] wœ4Ω [U+95F4] A=Θ
i [U+53D8] [U+7EBF] nBWΠ= [U+4F60] ˊ¯ [U+6837] A [U+8F93] w?E‘ [U+6837] WA=l [U+65F6] [U+95F4] [U+5BF9] [U+5E94]

3.7 [U+6B65] [U+9AA4] 9: Π [U+8FC7] [U+68C0] [U+6D4B] ß [U+8FDB] Λ [U+62DF]

TA [U+7EC3] [U+4E60] hXE [U+68C0] [U+6D4B] ß– [U+4E3A] [U+8F93] o [U+89C2] 3 [U+8F93] wΘ [U+4F60] Ia. [U+8F93] wJˇΠXM
X [U+68C0] [U+6D4B] ßAe [U+6B65] h [U+4EA7] yE¯ [U+9002] A [U+8F93] Jˇ ΘEjlhXMATLABAsweepRW([U+89C1] sweep.m[9]
([U+89C1] save_test_vector.m[10])a [U+4EA7] yAvœ5oEaXSDSPb [U+7801] A%bΘ
lMATLAB [U+4EA7] yΠJ5 [U+8FD9] [U+6837] Ev¡ [U+9891] œaXY:

```
≫ t=sweep(0.1*pi,0.9*pi,0.25,500);    % Generate a frequency sweep
≫ save_test_vector('testvect.asm',t); % Save the test vector
```

Yo,XMATLABAconvoyo:gen_filt [U+4EA7] yA [U+6EE4] œHh [U+5BF9] [U+8BE5] v¡ [U+9891] œA [U+62DF] [U+54CD] [U+5E94
$n+m-1$, nh [U+6EE4] œHA [U+957F] p,mh [U+8F93] Jˇ ßA [U+957F] p)AßΘ [U+4F60] [U+5E94] –J.ßA500EßΘ

```
≫ out=conv(h,t)                    % Filter t with FIR filter h
≫ out=out(1:500)                   % Keep first 500 elements of out
```

[U+73B0] l [U+4EEC] DˆK%bfilter.asmoX [U+68C0] [U+6D4B] ß ˚ %bvectcore.asm[11]Θ [U+8BE5] ˚ %bXA [U+8F93] [U+8F93] wV

: [U+68C0] [U+6D4B] ß5 [U+8D2E] l [U+4E3A] .etextA5ΛßΘ [U+5173] SDSP5ßA [U+7EC6] [U+8282] a [U+89C1] Core
File: Introduction to Six-Channel Board for TI EVM320C54[12]Θ

5 [U+8D2E] [U+68C0] [U+6D4B] ßA5ΛßaM [U+7EB3] [U+957F] [U+8FBE] 4000Aß,T5 [U+8D2E] [U+8F93] Jˇ W[,` 5 [U+8D2E] 46EΠA
ˆX [U+6D4B] [U+8BD5] ß, [U+4F60] DˆK%bfilter.asmΘ [U+6C47] [U+7F16] b [U+7801] %bh [U+7B80] [U+5355] A%, [U+4F6

```
.copy  "core.asm"
```

[8] "Two's Complement and Fractional Arithmetic for 16-bit Processors" <http://cnx.org/content/m10808/latest/>
[9] See the file at <http://cnx.org/content/m11893/latest/sweep.m>
[10] See the file at <http://cnx.org/content/m11893/latest/save_test_vector.m>
[11] See the file at <http://cnx.org/content/m11893/latest/vectcore.asm>
[12] "Core File: Introduction to Six-Channel Board for TI EVM320C54" <http://cnx.org/content/m10513/latest/>

[U+4E3A]:

```
.copy  "testvect.asm"
.copy "vectcore.asm"
```

œ¡[U+6837]ı.copyΩAΩEΛßΘ
[U+8FD9]@[U+53D8]˚[U+4F60]yoA[U+6D4B][U+8BD5]ß¸[U+8D1D][U+8FDB]oXæA˚%bΘΨob[U+7801]AKΠ[U+6C47][U
Composer[U+8F7D]%b[U+8FD0]ΛΘ[U+949F]DSP(XDebugg[U+5355]YAHalt),[U+786E][U+8BA4]DSPhl+A[U+8F6C][U+8B
DSP has halted at a branch statement that branches to itself)Θldisassemblyt[U+5E94]40000:611F F073 B
611fhj[U+663E]Θ
YoJ5[U+8F93]w%b[U+8F7D]MATLABΘ¡J5S0x8000A15A3000E[U+5355]ΘlCode Composer Studio[U+9009][U+62E9]Fi
T,Xread_vector([U+89C1]read_vector.m[13])J5A[U+7ED3]i[U+8BFB]MATLABΘXY:

```
≫ [ch1, ch2] = read_vector('output.dat');
```

[U+73B0]l,MATLABßch1[U+5BF9][U+5E94]S[U+7ECF][U+8FC7][U+8FC7][U+6EE4]A[U+6D4B][U+8BD5]ßΘMATLABßch2[

: :Sl[U+6D4B][U+8BD5]ß5DSP165[U+8FC7]1AZ[U+8BEF]F,[U+5B9E][U+9645]ßch2[U+7ECF]aıFMATLAB[U+4EA7]yA[

l[U+6EE4]œHA[U+8F93]w[U+8F7D]MATLAB,[U+8F83]UQ[U+8F93]w(out)Π[U+6EE4]œHA[U+5B9E][U+9645][U+8F93

```
≫ plot(out,'r'); % Plot the expected curve in red
≫ hold on        % Plot the next plot on top of this one
≫ plot(ch1,'g'); % Plot the expected curve in green
≫ hold off
```

[U+4F60][U+5E94][U+786E]#[U+4E24]E[U+8F93]wœ4Ω[U+95F4]AF[U+522B][U+4E3A]Θ[U+4F60]aXYjlw[U+4E24]EßAF

```
≫ plot(out-ch1); % Plot error signal
```

[U+4F60]˜[U+8FD9][U+4E24]ÆΨΨΘhDSPXAh16–p;MATLABl[U+8BA1]XAh64WWΘ
lX[U+8FD9][U+79CD]jl[U+8F83][U+4E24]Eß[U+65F6],[U+4E24]ÆA[U+957F]p[U+987B]Ψ[U+6837],XAMATLABout=o

[13]See the file at <http://cnx.org/content/m11893/latest/read_vector.m>