FCJL8&5fJs9p=q

ReVolver/**C40** $N
%7%9%F% `%3%s%H%m!<%k%f%K%C%H

;XF36541 IYEDbC<#65<x

5~ETBg3X9)3XIt>pJs9)3X2J

=EEDBg=u

J?@.10G/27n13F|

ReVolver/**C40** $N
%7%9%F%‘%3%s%H%m!<%k%f%K%C%H

=EED Bg=u

FbMF9<35

3 <!856u4V$r%\%/%;%k$H8FPl$kC10IN)J}BN$NItJ,6u4V$N=89g$G9=@.5l$F$$$k$H9M$(!"3N6u4V$r2 <!85$N%9%/%j!<%s$KEj1F$9k3HKhC$F!">pJs$N2D;k2=$r9T$&5;K!$r%\%j%e!<%‘%l%s%@%j%s%0$H8F$V!#%\%j%e!<%‘%l%s%@%j%s%0GO!"J*BN$NI=LL$@1GJ/!"$=$NFbIt$N9=B$$K$D$$$F$b2hA|$H7FI=8=9k3H$,$G$-$k!#5i$K!"$OC-jH7?6-3&$r;}$?$J$$?tCM2r@O%G!<%?$dE}7W%G!<%?$N2D;k2=rb9T$&<jCJ$H7F!"=EMW;k5l$F$$$k!#7+$7!"$3$N<jK!$N<B8=KOKDBg$J5-21MFNL$H7W;;NLrMW9$k!#

$=$3$G2f!9$O!"%\%j%e!<%‘%l%s%@%j%s%0$r9bB.$K9T$&@lMQJBNs7W;;5! *Re-Volver*/C40 $r3+H/Cf$G$"$k!#*ReVolver*/C40 $O2hA|@8@.=hM}$r;k@~@8@./%T%/%;%kCM7W;;/%7%'!<%G%#%s%0=hM}$H$$$&3 DN=hM}$KJ,3d$7!"%Q%$%W%i%$%s=hM}$r9T$&3HKhCF!"9bB.I=<($r2DG=$H7F$$$k!#>e5-$N3 DN=hM}r9$k%9%F!<%8r=l>$l!"%l%$%-%c%9%F%#%s%0%9%F!<%8(RCS)!"%T%/%;%kCM7W;;%9%F!<%8(PCS)!"%7%'!<%G%#%s%0%9%F!<%8(SS) $H8F$V!#3l$i3 DN%9%F!<%8$OFHN)$K=hM}$r9T$&NG!"A4BN$N@)8f$r9T$&I,MW$,$"$k!#$=3GK\9FGO!"%[%9%H%^%7%s$+iAwil?%3%^%s%I/%G!<%?$K=>CF!"3F%9%F!<%8$N@)8f$r9T$&%7%9%F%‘%3%s%H%m!<%k%f%K%C%H(SCU) KD$$$F=RYk!#

SCU $,K~$?9Y$-MW7o$H7F!"3F%9%F!<%8XN%G!<%?$NE>Aw!"1i;;$r9T$&Digital Signal Processor(DSP) $N%V!<%H!"@)8f?.9f$N6!5k!"%[%9%H%^%7%s$H*Re-Volver*/C40 $N%$%s%?%U%'!<%9!"%f!<%6%$%s%?%U%'!<%9$NDs6!$,$"$k!#DSP $N%V!<%H$O%9%F!<%8Kh$KO[$JkN$G!"$=lrK~$?$9%G!<%?$NE>Aw$NJ}K!$r<B8=$9kI,MW,$"$k!#3l$r9MN8$7$F!"SCU $N@_7W!"<BAu$r9TC?!#

%[%9%H%^%7%sHO9bB.$JI/O %P%9$G$"$kPCI %P%9$rMQ$$$F!"%G!<%?$NAw<u?.$r9T$&!#RCS HO View Buffer $H8F$Plk6&M-%a%b%j$r2p$7$?DL?.$r9T$&!#PCS $HSS XO!"2 DN%G!<%?$NE>Aw7PO)$NIAi+$rMQ$$$F%G!<%?$NAw<u?.$r9T$&!#Bh1 $NJ}K!$O!"DSP $N;}$DDL?.%]!<%H(Com Port) $rMQ$$$?J}K!G"$k!#$3lO!"PCS $HSS $NDSP $N%V!<%H$K;HMQ9k!#Bh2 $NJ}K!$O!"2hA|@8@.

;~K*$$$F;k@~%G!<%?$d%T%/%;%kCM%G!<%?$rE>Aw9kFIFO 7O$N7PO)$rMQ$$$kJ}K!G"$k!#$3$NJ}K!$O@h$K=R$Y$?J}K!$hjb9bB.$K%G!<%?E>Aw$r9T$&$3H,2DG=G"$k!#$7$+$7!"K\Mh$3$N7PO)$OPCS Fb$G$O!"%T%/%;%kCM$NE>AwN_$r9T$&$?$a!"$=$l0J30$N%G!<%?$NE>Aw$r9T$&$HLdBj$,@8$8!"$3$NJ}K!$rMQ$$$k$?$aKO!"LdBj$r2r7h$9kI,MW,$"$k!#

View Buffer!"PCS $*$h$SSS HNCom Port JiSKSCU FbIt$N%1%8%9%?$r%a%b%j6u4V$K%^%C%T%s%0$9$k!#$3lKhj!"%[%9%H%^%7%s$+$i$O*ReVolver*/C40 $r%a%b%j$H7F%"%/%;%9$9$k3H$,$G$-$k!#

ReVolver/C40 $r<B:]$K;HMQ9k3H$rA[Dj$7F_$k!#1 2hLL$N2hA|@8@.=hM}KMW9$k;~4V$O398msec G"$j!"JQ99$,=*N;7?;~E@$+$i7k2L$,H?1G$5lk$^$G$N;~4V$,<BMQ>eLdBjHJk3HO$J$$!#7+$7!"%\%j%e!<%`%G!<%?$NJQ99$r9T$&;~$K$O!"%\%j%e!<%`%G!<%?<+BN$,5pBg$J%G!<%?G"k?aK!"$=$NE>AwKMW9$k;~4V$,*ReVolver*/C40 $N<BMQ@-$KBg$-$J1F6A$rM?$($k!#

hC$F!"*ReVolver*/C40 $G%\%j%e!<%`%G!<%?$NE>Aw$r9T$&;~KI,MWH9k;~4V$r7W;;$7!"$=$N7W;;2aDx$HK\SCU $N@_7W$+$i8=:_$N*ReVolver*/C40 KD$$$F9M;!$r9T$C$?!#

%\%j%e!<%`%G!<%?$NE>Aw$O!"Com Port $rMQ$$$?E>Aw$h$j$b9bB.$JFIFO 7O$N7PO)$rMQ$$$k!#%\%j%e!<%`%G!<%?$O*ReVolver*/C40 GO!"3 =E2=7F5-21$7$F$$$k$,!"$=N?aN=hM}$OPCS Fb$G9T$&!#$3$NJ}K!$G$O!"%\%j%e!<%`6u4VFb$NA4%\%/%;%k$r!"PCS $N%\%j%e!<%`%a%b%j$K3JG<9k$?$a$K8.05sec rMW9$k!#1%U%l!<%`$N2hA|@8@.;~4V$O398msec G"kN$G!"E>Aw;~4V$O2hA|@8@.;~4VN*h=20 G\$G$"$k!#

3l$O%\%j%e!<%`%G!<%?$rE>Aw$9$k7PO)$,RCS $r7PM3$9$k$?$a$G$"$j!"SCU $+$iPCS $XFIFO 7O$N7PO)$rMQ0U$9$l$P!"E>Aw;~4V$rC;=L$9$k$3$H$,$G$-$k!#$^$?!"$3$NFIFO 7O$N7PO)$O!"E>Aw;~4V$,%G!<%?$NE>AwNL$KHfNc$9$k$N$G!"%\%j%e!<%`%G!<%?$NJQ99NL$,>/$J$/!"%\%j%e!<%`6u4VFb$NA4%\%/%;%k$rPCS $KAw?.$9kI,MW,$J$$>l9gKO!"E>Aw;~4V$rC;=L$9k3H,G-$k!#

%\%j%e!<%`%G!<%?$rMQ$$$?%1%$%H%1!<%7%s%0$G$O!"SS $+$iRCS $X$N%G!<%?E>Aw$,IT2D7g$G$"$k!#K\SCU $r7PM3$9$l$P!"$3$N%G!<%?E>Aw$r9T$&$3$H$,$G$-!"*ReVolver*/C40 $ODL>o$N%\%j%e!<%`%l%s%@%j%s%0N_Ji$:!"%\%j%e!<%`%G!<%?$rMQ$$$?%1%$%H%1!<%7%s%0$r9T$&$3H,2DG=HJ$k!#

System Control Unit of *ReVolver*/C40

Daisuke Shigeta

Abstract

Volume rendering is a technique to visualize information by projecting the three dimensional space onto the two dimensional screen. The object in this space can be regarded as a set of unit cubes. They are called voxels. Volume rendering enables us to see not only the surface of objects but also the inside of objects. And to visualize the results of numerical analysis and statistics which don't have clear boundaries volume rendering is used. But it requires enormous amount of storage and large computation time.

Therefore we are developing a parallel volume rendering computer '*ReVolver*/C40'. This machine can generate images fast by the pipelining of three independent processes. Pipelining stages for these processes are called Ray Casting Stage(RCS), Pixel Calculation Stage(PCS) and Shading Stage(SS), respectively. It is necessary to control the whole system, because these three stages are computing independently. Thus this paper describes System Control Unit(SCU) which receives commands and data from the host machine, and controls each stage of *ReVolver*/C40.

The following five functions are requirements to SCU. The first function is to transmit data to each stage, the second is to boot Digital Signal Processors(DSPs) in each stage, the third is to supply the control signals, the fourth is to communicate with the host machine, and the fifth is to provide a user interface. The way to boot DSPs in RCS is different from that in the other stages. The way to transmit data to RCS is different from that in the other stages. By taking this into consideration, SCU is designed and implemented.

SCU receives commands and data from the host machine with PCI bus which is the high speed I/O bus. SCU communicates with RCS by using View Buffer which is a shared memory in RCS. SCU has two ways to transmit data to PCS and SS. One is the way to use the communication ports in DSPs. They are called Com Port. This way is used when SCU boots DSPs in PCS and SS. Another is the way to use the path through FIFOs to transmit ray data and

pixel values at the time of generating images. The time to transmit in this way is less than the time to transmit in the previous way. However there are the problems in this way, because other data are transmitted by using the path only to transmit pixel values in PCS. It is necessary to settle these problems, when this way is used.

Mapping the View Buffer, Com Port to PCS, Com Port from SS and SCU control registers in the memory space enables the host machine to access *ReVolver*/C40 as memory.

Let us suppose that we use *ReVolver*/C40. It takes 398 milliseconds to generate an image. The time to reflect the change in the image generation parameter doesn't have any influence to the availability of *ReVolver*/C40. But the time to transmit volume data has a strong influence on availability of *ReVolver*/C40, because the size of volume data is large.

Therefore availability of *ReVolver*/C40 is considered on the process to calculate the time to transmit volume data in *ReVolver*/C40 and the design of SCU.

The path through FIFOs is used to transmit volume data, because the speed of the transmission by the path through FIFOs is higher than by Com Port. It takes 8.05 seconds to store all the voxels in the volume space in volume memory. This time is twenty times as long as the time to generate an image, because it takes 398 milliseconds to generate an image.

This is because of the path to transmit volume data via RCS. Construction of a direct path with FIFO memory from SCU to PCS enables *ReVolver*/C40 to reduce the time of the transmission. If SCU doesn't have to transmit all voxels in the volume space to PCS, the time of the transmission is reduced, because the time of the transmission by the path through FIFOs is in proportion to the amount of the transmission.

In the ray tracing by volume data, it is necessary to transmit data from SS to RCS. This SCU enables *ReVolver*/C40 to transmit data from SS to RCS. Therefore *ReVolver*/C40 can compute not only by volume rendering but also by the ray tracing by volume data.

ReVolver/**C40** $N

%7%9%F%`%3%s%H%m!<%k%f%K%C%H

L\<!

1 O8aK **1**

2 *ReVolver*/**C40** $N35MW **1**

2.1 %\%j%e!<%`%l%s%@%j%s%0 1

2.2 *ReVolver*/C40 $NFCD' 2

2.3 *ReVolver*/C40 $N9=@. 3

2.4 %l%$%-%c%9%F%#%s%0%9%F!<%8$N9=@. 3

2.5 %T%/%;%kCM7W;;%9%F!<%8$N9=@. 5

2.6 %7%'!<%G%#%s%0%9%F!<%8$N9=@. 6

3 %7%9%F%`%3%s%H%m!<%k%f%K%C%H **7**

3.1 MW5a;EMM 7

3.2 @_7WJ}?K 7

3.2.1 *ReVolver*/C40 %f%K%C%H4V@\B3$K4X$9$k@_7WJ}?K 7

3.2.2 SCU FbIt%"!<%-%F%/%A%c$K4X$9$k@_7WJ}?K 8

3.3 9=@. 9

3.3.1 %O!<%I%&%'%" 9

3.3.2 PCI %P%9%$%s%?%U%'!<%9 11

3.3.3 *ReVolver*/C40 $N3F%9%F!<%8$H$N%$%s%?%U%'!<%9 13

3.3.4 4pK\%W%j%_%F%#%V 14

3.4 SCU $r2p$7$?*ReVolver*/C40 $N@)8f 16

3.4.1 3F%9%F!<%8$NDSP $N%V!<%H 16

3.4.2 *ReVolver*/C40 $N3F%9%F!<%8$N@)8f 16

3.4.3 3F<o%G!<%?E>Aw 17

3.4.4 %f!<%6%$%s%?!<%U%'!<%9 20

4 %\%j%e!<%`%G!<%?$NE>Aw **21**

4.1 %\%j%e!<%`%G!<%?$N3 =E2= 22

4.2 %\%j%e!<%`%G!<%?$NE>Aw;~4V 22

4.3 9M;! 23

5 $*$ojK **24**

<UK- **25**

;29MJ88% **25**

IUO? **A-1**

A.1 %a%$%s%\!<%IG[@~?^ A-1

A.2 %a%$%s%\!<%I4pHDG[CV?^ A-2

1 O8aK

%\%j%e!<%`%1%s%@%j%s%0$O!"3<!856u4V$rC10lN)J}BN(%\%/%;%k$H8F$V) $NItJ,6u4V$G9=@.5l$F$$$k$H9M$(!"3N6u4V$r2<!85$N%9%/%j!<%s$KEj1F$9$k5;K!$G$"$k!#3N5;K!$O=>Mh!"0eNE2hA|J,Ln$K$*$$$F?MBNFbIt$N2D;k2=$r9T$&>e$G=EMWG"C?!#5i$K6aG/$G$O!"%9!<%Q!<%3%s%T%e!<%?$JIN9bB.$J7W;;5!$rMxMQ7?2J3X5;=Q7W;;$N7k2L$N2D;k2=Kh$k2r@O<jK!$H7F$b=EMW;k$5lF$$$k!#

$=$N$?$a!"2f!9$O%\%j%e!<%`%1%s%@%j%s%0$r9bB.$K9T$&@lMQJBNs7W;;5!*ReVolver*/C40 $r3+H/$7$F$$$k!#*ReVolver*/C40 GO;k@~@8@.!"%T%/%;%kCM7W;;!"%7%'!<%G%#%s%0$+$iJk3%9%F!<%8$N%Q%$%W%i%$%s=hM}$r9TCF$*$j!"8_$$$KFHN)7F2D;k2==hM}$r9T$C$F$$$k!#$=$3$G!"*ReVolver*/C40 A4BN$N@)8f$r9T$&$?$a$N%f%K%C%H$,I,MWHJCF$/$k!#$=$l$,%7%9%F%`%3%s%H%m!<%k%f%K%C%H(SCU) G"$k!#

K\9FGO!"%[%9%H%^%7%s$+$i%3%^%s%I/%G!<%?$r<u$1<h$j!"3F%9%F!<%8$N@)8f$r9T$&SCU KD$$$F=RYk!#2>OGOGX7JH7$F*ReVolver*/C40 $NFCD'$H9=@.!"5i$KSCU $N9=@.$H?<$/4X$ok=l>lN%9%F!<%8$N9=@.$K$D$$$F=RYk!#3>OGOSCU KBP9$kMW5a$H$=$N<B8=J}K!KD$$$F6qBNE*$K=R$Y!"4>OGO%\%j%e!<%`%G!<%?$NE>Aw$NJ}K!!"=hM};~4VKD$$$F=R$Y!"8=:_$N9=@.$N*ReVolver*/C40 KD$$$F9M;!$r9T$&!#5>OGOA4BNKD$$$F$^$Hak!#

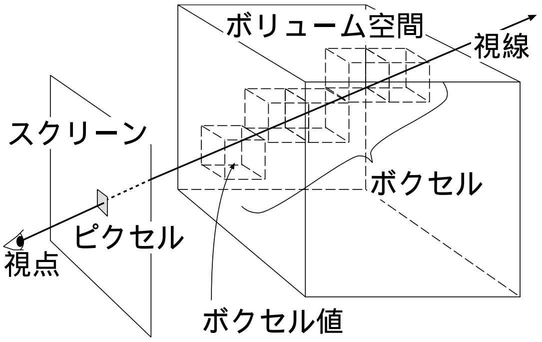
2 *ReVolver*/**C40** $N35MW

2.1 %\%j%e!<%`%1%s%@%j%s%0

%\%j%e!<%`!&%S%8%e%"%i%$%<!<%7%g%s$O!"3<!85%*%V%8%'%/%H$rFbIt>pJs$r;}$C$?3<!85%G!<%?(%\%j%e!<%`%G!<%?) $GI=8=$7!"3N%\%j%e!<%`%G!<%?$r2D;k2=$9k3HrL\E*H7$F$$$k!#3N7k2L!"J*BN$NFbIt$r2r@O9k3H$,$G$-$k!#

%\%j%e!<%`%G!<%?$O!"%\%/%;%k$H8FPl$kItJ,6u4V$N=89gH7$FI=$5lk!#3F%\%/%;%kKO2J3X5;=Q7W;;JIKhCFF@il$?%G!<%?$NB0@-CM$,M?$(il$k!#$3$NB0@-CM$r%\%/%;%kCM$H8F$V!#

%\%j%e!<%`%S%8%e%"%i%$%<!<%7%g%s$r9T$&J}K!$H$7$F!"%\%j%e!<%`%1%s%@%j%s%0$H8F$PlkJ}K!$,$"$k!#%\%j%e!<%`%1%s%@%j%s%0$O!"%\%j%e!<%`%G!<%?$r



?^2.1: %\%j%e!<%`%l%s%@%j%s%0

9=@.9k3F%\%/%;%k$r%9%/%j!<%s$KEj1F9k3HKh$j2hA|$r@8@.9kJ}K!G"$k!#%\%j%e!<%`%l%s%@%j%s%0$N35G0?^$r?^2.1$K<($9!#

2.2 *ReVolver*/**C40** $NFCD'

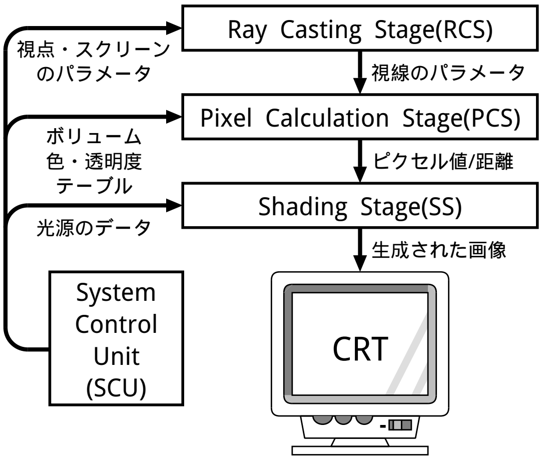
ReVolver/C40 $O!"2J3X5;=Q7W;;$N2r@O$dN.BN$N2D;k2=$r%\%j%e!<%`%l%s%@%j%s%0$rMQ$$$F9T$&$?$a$K!"9bB.IA2h!"H>F)L@%\%j%e!<%`$NI=<(!"1s6aK!Kh$k2hA|@8@.$H$$$&3 DN9`L\$r<B8=9kh&$K@_7W$5lF$$$k!#

$=$N$?$a$K*ReVolver*/C40 $,;}$DFCD'$O0J2<$N4 DG$"$k!#

%l%$%-%c%9%F%#%s%0K!$N:NMQ ;kE@$+$i%9%/%j!<%s>eN"$k%T%/%;%k$NCf?4XH8~$+$&%Y%/%H%kN3Hr;k@~%Y%/%H%k$H8F$S!";kE@$r0lC<$H$7%T%/%;%k$NCf?4rDLkH>D>@~$r;k@~$H8F$V!#%l%$%-%c%9%F%#%s%0K!GO%9%/%j!<%s>e$N%T%/%;%k$4HK!";k@~$,$I$N%\%/%;%k$rDL2a7F$-$?N+$rDI@W$7$F!"%T%/%;%k$N?'$dL@$k5r7hDj$7!"%9%/%j!<%s$KEj1F9k!#

%5%s%W%j%s%0J}K!$NC1=c2= *ReVolver*/C40 GO!";k@~%Y%/%H%k$N@.J,$N@dBPCMN&$A!":GBgCM$rbD:BI8<4$r<g<4$HDj$a!"$3$N<g<4$NJ}8~KBP7$FEy4V3V$K%\%/%;%k$r%5%s%W%j%s%0$9$kJ}K!$r:NMQ7F$$$k!#3NJ}K!$r<g<4Ey4V3V%5%s%W%j%s%0K!$H8F$V!#

%P%s%/%3%s%U%j%/%HNJ$$%a%b%j9=@. <g<4Ey4V3V%5%s%W%j%s%0K!GO!"$"$k:BI8<4$K?bD>$JJ?LL$K%\%j%e!<%`%G!<%?$rJ,3d7F%a%b%j%P%s%/$K3JG<$9lP!"$=$N:BI8<4$r<g<4$H7F;}$D;k@~$K4X7F$O%P%s%/%3%s%U%j%/%H%U%j!<HJ$k!#$7$+$7!"G$0UJ}8~$N;k@~$N<g<4$,!"3N:BI8<4$r<g<4$H7F;}DH$O8B$i$J$$!#$=$3$G!"x,y,z <4$N$$$:lK$b?bD>$JJ?LL$,B8:_$9kh$&$KJ,3d9lPG0UJ}8~$N;k@~$KBP7F%P%s%/%3%s%U%j%/%H%U%j!<H9$k



?^2.2: *ReVolver*/C40 $NA4BN9=@.

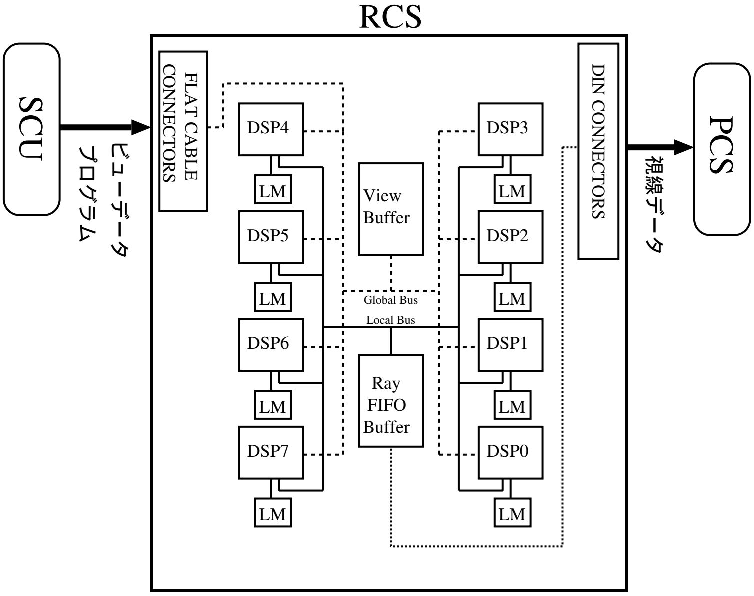
3H$,$G$-$k!#*ReVolver*/C40 $N3<!85%a%b%j9=B$$G$O!"%\%j%e!<%`%G!<%?$r3=E2=$7!"<g<4Ey4V3V%5%s%W%j%s%0$r9T$&3HKh$j!";k@~$,G$0UJ}8~$G$"$CFb!"%P%s%/%3%s%U%j%/%H$,@8$8$J$$$3HrJ]>Z9k!#

JBNs=hM}Kh$k9bB.2= *ReVolver*/C40 $O!"A4BN$H7F%1%$%-%c%9%F%#%s%0%9%F!<%8(RCS)!"%T%/%;%kCM7W;;%9%F!<%8(PCS)!"%7%'!<%G%#%s%0%9%F!<%8(SS)$H$$$&3 8D$N%9%F!<%8$Khk%Q%$%W%i%$%sKh$j9=@.$5lk!#$^$?!"RCS GOM?$($il?>pJs$r%9%/%j!<%s$rJ,3d7F3FProcessing Element(PE) $K3d$jEv$F!";k@~@8@.=hM}$r9T$&!#PCS GO%T%/%;%kCM7W;;$r%Q%$%W%i%$%s=hM}$G9T$&!#SS GO%9%/%j!<%s$rJ,3d$7$F3FPE $K%T%/%;%kCM$r3djEvF!"%7%'!<%G%#%s%0$r9T$&!#3Nh&$K3F%9%F!<%8$G$bMM!9$JJBNs=hM}$r9T$&3HKhCF!"9bB.2=$r?^$C$F$$$k!#

2.3 *ReVolver*/**C40** $N9=@.

ReVolver/C40 $O?^2.2$K<(9h$&$K!"RCS!"PCS!"SS $H8F$Plk3 DN%9%F!<%8KhCF9=@.5lF*$j!"$3li$,FHN)$K=hM}$r9T$&3HKhCF!"JBNs=hM}$r<B8=$7$F$$$k!#3N3 DN%9%F!<%8r^Ha$F@)8f$7$F$$$kN,%7%9%F%`%3%s%H%m!<%k%f%K%C%H(SCU) $G$"$k!#SCU $O!"%7%9%F%`A4BN$N@)8f$r9T$$!"%[%9%H%^%7%s$+$i$N;X<($K7?$,$C$F!"B>$N9=@.MWAGKBP7$F%3%^%s%I/%G!<%?$rE>Aw9kN,$=$NLr3dG"$k!#

2.4 %1%$%-%c%9%F%#%s%0%9%F!<%8$N9=@.



?^2.3: RCS $N9=@.

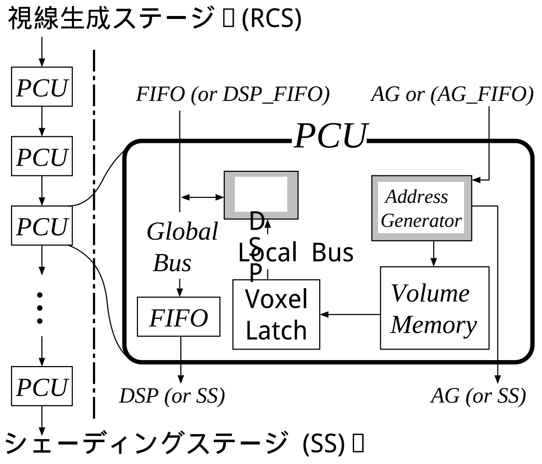
RCS $O?^2.3$K<(9h$&$K9=@.5l$k!#RCS $N9=@.MWAG$O0J2<$N4 DG$"$k!#

View Buffer A4PE $HSCU $G6&M-$5lk%a%b%j$G!"SCU $+$i$N;kE@%9%/%j!<%s$N%Q%i%a!<%?(%S%e!<%G!<%?)!"Digital Signal Processor(DSP) $N%W%m%0%i%`$JIrJ];}9k!#View Buffer $O64Kword $NMFNL$rbDSRAM $G9=@.$5lk!#;k@~@8@.=hM};~KO!"SCU $HRCS Fb$NPE HN%"%/%;%96%9gO[HsIJ$$$N$G!"View Buffer $O%7%s%0%k%]!<%H9=@.$HJC$F$$$k!#

PE *ReVolver*/C40 GOPE $KTMS320C40 $H$$$&DSP $r;HMQ$7$F$$$k!#TMS320C40 $OGlobal Bus $*$h$SLocal Bus $HL>IU$1il$?2 DN%P%9rb$D[11]!#

30It%m!<%+%k%a%b%j 3F PE $,8D!9$K;}$D30IU$1$N%m!<%+%k%a%b%j$G!"MFNL64Kword $NSRAM $G9=@.$5lk!#

Ray FIFO Buffer PE $N@8@.$7$?;k@~%G!<%?$r<u$1<h$kFIFO(First-In First-Out) %a%b%j$G!"2 %]!<%H$N$&$A1 %]!<%H$KRCS $,;k@~%G!<%?$r=q$-9~$_!"b&0lJ}$N%]!<%H$+$iPCS $,;k@~%G!<%?$rFI$_=P$9!#PCS GO!"%5%s%W%j%s%0$9$k%\%/%;%k$N%"%I%l%97W;;$rAddress Generator(AG) $,9T$$!"%T%/%;%kCM7W;;$rDSP $,$=l>$lFHN)$K9T$&$N$GAG-FIFO Buffer!"DSP-FIFO Buffer $N2 <oN`$NRay FIFO Buffer $r@_$1!";k@~%G!<%?$NE>Aw$O8DJL$K9T$&!#Ray FIFO Buffer KO?<$564!"I}36bit $NFIFO %a%b%j$r;HMQ



?^2.4: PCS $N9=@.

9k!#

2.5 %T%/%;%kCM7W;;%9%F!<%8$N9=@.

PCS $O%P%s%/%3%s%U%j%/%H%U%j!<$N%a%b%j$+iFI_=P5l$?%\%/%;%kCM7W;;$r!"%Q%$%W%i%$%sE*$K=hM}$9$k!#$=3G!"PCS $O!"PE $H%a%b%j$r#1DN%f%K%C%HH7$?%T%/%;%kCM7W;;%f%K%C%H(PCU) $r1<!85$K@\B3$9$k9=@.$r;}$D!#PCS $N9=@.$r?^2.4$K<($9!#

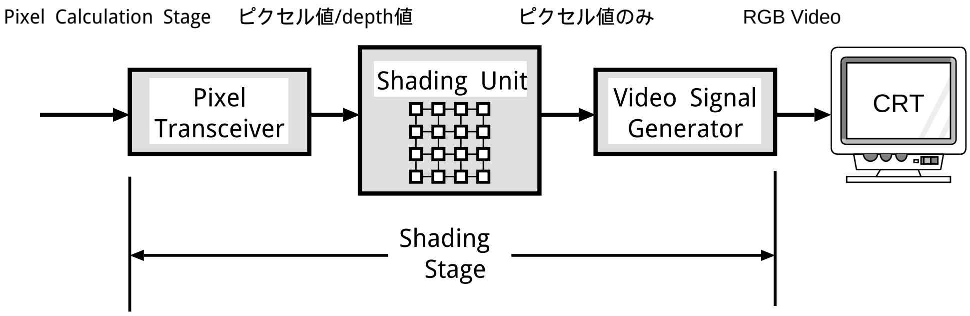
PCU $N9=@.MWAG$O<g$K5$DG"$k!#0J2<$KPCU $r9=@.$7$F$$$k3FMWAGKD$$$F@bL@9k!#

PE RCS $HF1$8$/TMS320C40 $r;HMQ$7!"3NDSP $G%T%/%;%kCM7W;;$d!"8r:9H=Dj$r9T$&[3]!#$^$?!"3FDSP $O%V!<%H$r9T$&$?aK!"A08e$NDSP $HCom Port $H8F$PlkDL?.%]!<%H$G@\B3$5lF$$$k!#

Address Generator %5%s%W%j%s%0$9$k%\%/%;%k$N%"%I%l%97W;;!"%\%/%;%kCMNFI_=P$7!"NY@\$9$kAddress Generator 4V$NDL?.$r9T$&!#$^$?DL>o$NDRAM Controller H7FN=hM}$dDSP $NLocal Bus $dVoxel Latch $N@)8f$b9T$&!#

FIFO <!CJ$NDSP XNAw?.$r9T$&$?aN%P%C%U%!!#DSP $+$iFIFO XN%"%/%;%9$O!"DL>o$N%m!<%I!?%9%H%"L?Na$G<B8=$G$-!"%&%'%$%HJ7GN%"%/%;%9$,9T$($k9=@.$KJC$F$$$k!#

3D Volume Memory %\%j%e!<%`!&G!<%?$r3JG<$7$F$$$kDRAM $G$"$k!#*ReVolver*/C40 $O!":GBg$512^3$%\%/%;%k$N%\%j%e!<%`6u4V$r0 7$&!#



?^2.5: SS $N9=@ .

Voxel Latch Address Generator KhCF%5%s%W%j%s%0$5$l$?%\%/%;%kCM$r DSP KhCFFI$_=P$5lk$^$GJ]; }7F$*$/! #3N5 !9=Kh$j DSP $+$i $N%&%'%$%HJ7GNFI$_=P$7$r<B8=$9$k[3]! #

2.6 %7%'!<%G%#%s%0%9%F!<%8$N9=@ .

SS GO! "%9%/%j!<%s$r 2 <!85%V%m%C%/J,3d(4 × 4 $N 16 J,3d) $7! "$=l>$l $r 1 DN PE $K3d$jEvFk3HKh$j! "%7%'!<%G%#%s%0$rJBNs$G9T$&! #

SS $O PCS $+$i$N%T%/%;%k%G!<%?$r<u$1<h$k Pixel Transceiver(PT)! "%7%'!< %G%#%s%0$r9T$& Shading Unit(SU) $H! "%S%G%*?.9f$KJQ49$7$F CRT $K=PNO$9$k Video Signal Generator(VSG) $G9=@ .$5lF$$$k[4]! #SS $N9=@ .$r?^2.5 $K< ($9! # 0J2<K=l>lK$D$$$F=RYk! #

Pixel Transceiver 3F%T%/%;%k$N%G!<%?$rA0$N%9%F!<%8$G$"$k%T%/%;%kCM7W ; ;%9%F!<%8$+$i<u1H$j! "C4Ev$9$k PE $N; }$D%a%b%j$K%G!<%?$r=q$-9~$` =hM}$r9T$&! #$=$N$?$a$N%"%I%l%97W; ;$b9T$&! #

Shading Unit 16 Bf$N PE $,! "DSP $,; }$D Com Port Kh$j3J; R>u$K7k9g$5 l?9=B$$KJC$F$$$k! #l 8D$N PE $O PT $+$i$N%G!<%?$r<u$1<h$k SRAM ! " VSG $K%G!<%?$r=PNO9k VRAM $H! "$=$N4V$N%7%'!<%G%#%s%0$r9T$& DSP $+$iJC$F$$$k! #SU $N PE $b RCS $d PCS $HF1MM$K! "TMS320C40 $r; HMQ 9k! #DSP $O Pixel Transceiver $+$i SRAM $K=q$-9~$^$l$?%G!<%?$rbH $K! "%7%'!<%G%#%s%0=hM}$r; \$7! "VRAM $K=q$-9~$`$H$$$&=hM}$r9T$C$F$$ $k! #$^$?! "SRAM KO30OIt$+iNF~NO%]!<%H(3HD%%P%9) $bMQ0U$9$k! #

Video Signal Generator SU $G%7%'!<%G%#%s%0=hM}$r=*$($F! "VRAM $+$i %7%j%"%k%/%m%C%/$KF14 |$7FAwilF$/$k%G%8%?%k$N RGB %G!<%?$r%"%J %m%0$N%S%G%*?.9f$KJQ49$7! "CRT $K=PNO$9$k! #

3 %7%9%F%`%3%s%H%m!<%k%f%K%C%H

3.1 MW5a;EMM

SCU $O!"%[%9%H%^%7%s$+iAwilk!"*ReVolver*/C40 KBP9$k=hM}%3%^%s%I$d%G!<%?$r<u$1Hj!"E,@Z$J=hM}$r9TCF!"*ReVolver*/C40 A4BN$N@)8f$r9T$&!# *ReVolver*/C40 KBP9$k=hM}$O!"A4$F%[%9%H%^%7%s$+$iSCU KBP7FN%G!<%?%"%/%;%9$r9T$&3H$G<B8=$9$k!#

SCU $KMW5a$5lk5!G=H7$F!"0J2<$N5 D,$"$2il$k!#

1. 3F%9%F!<%8XN%G!<%?$NE>Aw
   RCS ··· ;kE@$H%9%/%j!<%s$N%Q%i%a!<%?
   PCS ··· %\%j%e!<%`%G!<%?, ?′ · F)L@EY$N%F!<%V%k
   SS ··· 8w8;$N%G!<%?
2. 3F%9%F!<%8$N**DSP** $N%V!<%H
   3F%9%F!<%8K*$$$F1i;;=hM}$r9T$&DSP $N%V!<%H
   RCS ··· %a%b%j$+$i%V!<%H%W%m%0%i%`$rFI$_9~$`
   PCS,SS ··· Com Port $+$i%V!<%H%W%m%0%i%`$rFI$_9~$`
3. @)8f?.9f$N6!5k
   %j%;%C%H!"3d$j9~$_?.9f$r@8@.$7!"3F%9%F!<%8$K6!5k$9$k
4. %[%9%H%^%7%s$H*ReVolver*/**C40** $N%$%s%?%U%'!<%9
5. %f!<%6!<%$%s%?%U%'!<%9$NDs6!

3.2 @_7WJ}?K

3.2.1 *ReVolver*/**C40** %f%K%C%H4V@\B3$K4X$9$k@_7WJ}?K

SCU $H3F%9%F!<%8$H$N@\B3J}K!$O!"DSP $N%V!<%H$NJ}<0$K=>$&!#RCS $O%a%b%j$+$i%V!<%H%W%m%0%i%`$rFI$_9~$`$N$G!"RCS Fb$N6&M-%a%b%j$KSCU $r@\B3$9$k!#PCS $HSS $OCom Port $+$i%V!<%H%W%m%0%i%`$r<u?.$9kN$G!"SCU $+$iPCS $HSS $NA4DSP XNCom Port $rMQ$$$?%G!<%?E>Aw$r2DG=$H9k@\B3J}K!$rMQ$$$k!#

SCU $HRCS $N@\B3$OView Buffer $rMQ$$$F9T$&0J30$KA*Br;hOJ$$!#

8=:_$NPCS $N<BAu$G$O!"DSP $N;HMQ2DG=$JCom Port $O2 DG$"$k!#hC$F!"PCS $HSS $NA4DSP $rCom Port $rMQ$$$FSCU $H@\B3$9$kJ}K!$H7F!"0J2<$N2 D,9M$($ilk!#

1. C10 1%j%s%0J}<0

   NY@\$9$k DSP $r Com Port $G@\B3$7!"DSP 4VGN%G!<%?$NE>AwJ}8~$r8G Dj9k!#3N@\B34X78$rMQ$$$F!"PCS $H SS $NA4 DSP $*$h$S SCU $r%j%s%0>u$K@\B3$9$k!#

2. J#?t%j%s%0J}<0

   PCS $H SS $NA4 DSP $rJ#?t$N%0%k!<%W$KJ,3d$7!"%0%k!<%W$KB0$9$kA4 DSP $H SCU $,C10 1$N%j%s%0HJkh$&$K@\B3$9$k!#

J#?t$N%j%s%0$rMQ$$$k$H!"$=l>lN%j%s%0FbGNE>Aw$OF HN)$7$F9T$&3H$,$G$-$k!#%G!<%?$NE>AwNL$,>/$J$$>l9gKO!"J#?t$N%j%s%0$rMQ$$$kI,MWOJ$$!#*ReVolver/C40* $O!"2hA|@8@.=hM};~$K$*$$$F;k@~%G!<%?!"%T%/%;%kCM$NE>Aw$r9T$&32 %S%C%HI}$N FIFO $rMQ$$?7PO)$r;}$D!#Com Port $O8 %S%C%HI}$G$"$kNG!"J#?t$N%j%s%0$rMQ$$$F!"FIFO 7O$N7PO)$h$jE>Aw;~4V$r8:>/5;k?aK$O!"%j%s%0$N?t$r5 0J>e$K9kI,MW$,$"$k!#$7$+$7!"3NJ}K!$r<B8=$9k?aK$O!">/$J$/$H$b SCU $K10 8D$N Com Port $rG[CV$9kI,MW,$"$k!#hC$F!"BgNL$N%G!<%?E>AwKO FIFO 7O$N7PO)$rMQ$$!"Com Port GN@\B3$OC10 1%j%s%0J}<0$r:NMQ9k!#

3.2.2 SCU FbIt%"!<%-%F%/%A%c$K4X$9$k@_7WJ}?K

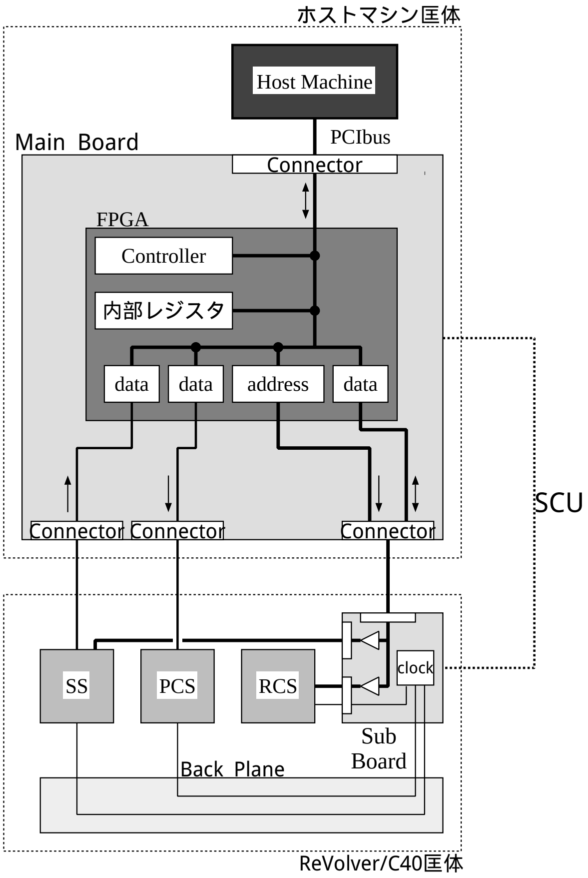
SCU Fb$K%W%m%;%C%5$rG[CV9k$H!"%[%9%H%^%7%s$N%W%m%;%C%5HOJBNs$K=hM}$r9T$&$3H,G-$k!#0J2<$KJBNs$K<B9T$G$-$k=hM}$r<($9!#

%G!<%?$NE>Aw　%G!<%?$NE>Aw$r%[%9%H%^%7%s$,9T$&$NGOJ/!"SCU $,%[%9%H%^%7%s$H$N%P%9$r;HMQ7F%G!<%?rFI_9~$_!"*ReVolver/C40* $N3F%9%F!<%8$XAw?.9k!#

%G!<%?$N2C9)　%[%9%H%^%7%s$+$i%m!<%I$7$?%G!<%?$K!"J#;($J=hM}$r;\$7$F *ReVolver/C40* XHE>Aw$r9T$&3H$,G-$k!#

%G!<%?$N@8@.　F~NO%G%P%$%9$r SCU $KMQ0U$9kH!"2hA|@8@.$K4X$9$k%Q%i%a!<%?$r SCU $G@8@.$9k3H,G-!"%[%9%H%^%7%s$+$i<u?.9kI,MWOJ$$!#

%G!<%?$NE>Aw$O!"%[%9%H%^%7%s$N Direct Memory Access(DMA) $rMQ$$$l$P!"%W%m%;%C%5$KIi2Y$rM?$($J$$!#%G!<%?$N2C9)$O!"%G!<%?$r<u?.$9$k *ReVolver/C40* $N PE $,HFMQ$N%W%m%;%C%5G"kN$G!"PE Fb$G=hM}$r9T$&3H$,$G$-$k!#%G!<%?$N@8@.$O!"%f!<%6%$%s%?%U%'!<%9$HJk%[%9%H%^%7%s$G9T$&!#hC$F!"SCU Fb$K%W%m%;%C%5$OG[CV$;$:!"Field Programmable Gate Array(FPGA) $rMQ$$$F@_7W$r9T$&!#



?^3.1: SCU $N9=@.

$^$?!"SCU Fb$K%a%b%j$rG[CV9k>19g!"%[%9%H%^%7%s$HSCU $N4V$N%G!<%?E>Aw$H*ReVolver*/C40 $N3F%9%F!<%8$HSCU $N4V$N%G!<%?E>Aw$r!"SCU Fb$N%a%b%jKBP7$F9T$&3H$,$G$-!"$=1>$1FHN)$K<B9T2DG=G"$k!#$7$+$7!"SCU $H3F%9%F!<%8$H$rE>Aw%P%C%U%!$rMQ$$$F@\B3$9$k$H!"%a%b%j$rMQ$$$J$/$H$b!"%[%9%H%^%7%sB&$NE>Aw$H*ReVolver*/C40 B&$NE>Aw$rFHN)$K9T$&$3H,G-$k!#E>Aw%P%C%U%!$OFPGA $G<B8=$G$-$k!#hC$F!"SCU Fb$K$O%a%b%j$rG[CV7J$$!#

3.3 9=@.

3.3.1 %O!<%I%&%'%"

3F%9%F!<%8$X6!5k$9$k%/%m%C%/$O!"*ReVolver*/C40 $N3F%9%F!<%8$N6a$/$G@8@.9kY-G"$k!#SCU $O%[%9%H%^%7%s$K@\B3$9$kNG!"3F%9%F!<%8$X6!5k$9$k%/%m%C%/$r!"$=$3$G@8@.$9kY$-$GOJ$$!#$^$?!"%/%m%C%/$O3F%9%F!<%84V$G0IAj$r9g$o$;$kI,MW$,$"$j!"1 %+=j$G@8@.9kY-G"$k!#$hCF!"SCU $O?^

3.1$K<($9h&$K!"%[%9%H%^%7%sB&$N%a%$%s%\!<%I$H!"*ReVolver*/C40 B&$N%5%V %\!<%I$H$G9=@.$7!"%5%V%\!<%I>e$G%/%m%C%/$r@8@.9k!#%a%$%s%\!<%I$O!"%[%9%H%^%7%s$N6)BN$K!"%5%V%\!<%I$O *ReVolver*/C40 $N6)BN$K3JG<9k!#%a%$%s %\!<%I$H *ReVolver*/C40 $N6)BNFb$N%\!<%IHN@\B3KO%U%i%C%H%1!<%V%k$rMQ $$$k!#

%[%9%H%^%7%s$H%a%$%s%\!<%I$O9bB.$JI/O %P%9G"$k PCI %P%9$rMQ$$$F@\ B3$9$k!#%a%$%s%\!<%I$O3 0ItHN%3%M%/%?$H FPGA $r@\B3$7$?9=@.$HJC$F $*$j!"%[%9%H%^%7%s$N PCI %9%m%C%H$K@\B3$9$k!#3.2.2@aGN@_7WJ}?K$K=>$$!" SCU $H *ReVolver*/C40 $N3F%9%F!<%8$H$N4V$KE>Aw%P%C%U%!$rG[CV$9$k!#PCI %P %9$O 3.3.2@a$G=R$Ykh$&$K!"%"%I%l%9$H%G!<%?$r;~J,3d$G6&M-$9$k!#$hCF!" %"%I%l%9$H%G!<%?$,FHN)7F$$$k View Buffer $H@\B3$9k?aK$O!"SCU $NFb It$G%"%I%l%9$H%G!<%?$r$=$l$>$lJ];}7F$*$/I,MW$,$"$k!#$3lr@h$K=R$Y$? E>Aw%P%C%U%!$rMQ$$$F9T$&!#$^$?!"Com Port $rMQ$$$?PCS $*$h$S SS HNDL ?.GO!"PCI %P%9$,%o!<%IC10L1) $N%"%/%;%9$G$"$kNKBP$7!"Com Port GNDL ?.$O%P%$%HC10L$G9T$olk!#hC$F!"Aj8_$K%G!<%?$NE>Aw$N7A<0$rJQ49$9k? $a!"SCU $,PCS $KAw?.$9$k%G!<%?!"SCU $,SS $+$i<u?.9k%G!<%?KD$$$F $b!"SCU $NFbIt$GJ];}9kI,MW$,$"$k!#$3lb@h$K=R$Y$?E>Aw%P%C%U%!$rMQ$$ $F9T$&!#

RCS C1BNGN%G%P%C%0;~KO!"%/%m%C%/$N0lIAj$r9go;kI,MWO$J$$!#hC F3$N>l9g$G$O!"%5%V%\!<%I$rMQ$$$kI,MWOJ$$!#RCS $HSCU $N%$%s%?%U%'!< %9$H!"%a%$%s%\!<%I$H%5%V%\!<%I$N%$%s%?%U%'!<%9$rEy7/9k3H$G!"%a%$ %s%\!<%I$KD>@\RCS $r@\B3$9k3H,G-$k!#

%5%V%\!<%I$O!"%/%m%C%/%8%'%M%l!<%?!"3F%9%F!<%8$N%/%m%C%/$N0lIAj$r9g$o$; $k Phase Locked Loop(PLL) $H!"%a%$%s%\!<%I$+$i$N%P%9$r@)8f9k%P%C%U%! $G9=@.$5lk!#%5%V%\!<%I$O *ReVolver*/C40 $N%P%C%/%W%l!<%s$K@\B3$5$l!"%P%C %/%W%l!<%srDL8$F PCS $*$h$S SS $N%/%m%C%/$H%j%;%C%H$r6!5k$9$k!#RCS $N %j%;%C%H$H%/%m%C%/$O View Buffer XN%P%9$,MQ$$$kNHF1$8%3%M%/%?$rMQ$$ $F6!5k$9$k!#%5%V%\!<%I$H View Buffer $*$h$S SS $H%5%V%\!<%I$O!"%U%i%C%H %1!<%V%k$rMQ$$$F@\B3$9$k!#

SCU $rMQ$$$?%G!<%?$NN.$l$r?^3.2$K<($9!#SCU $H RCS $N PE HO!"View

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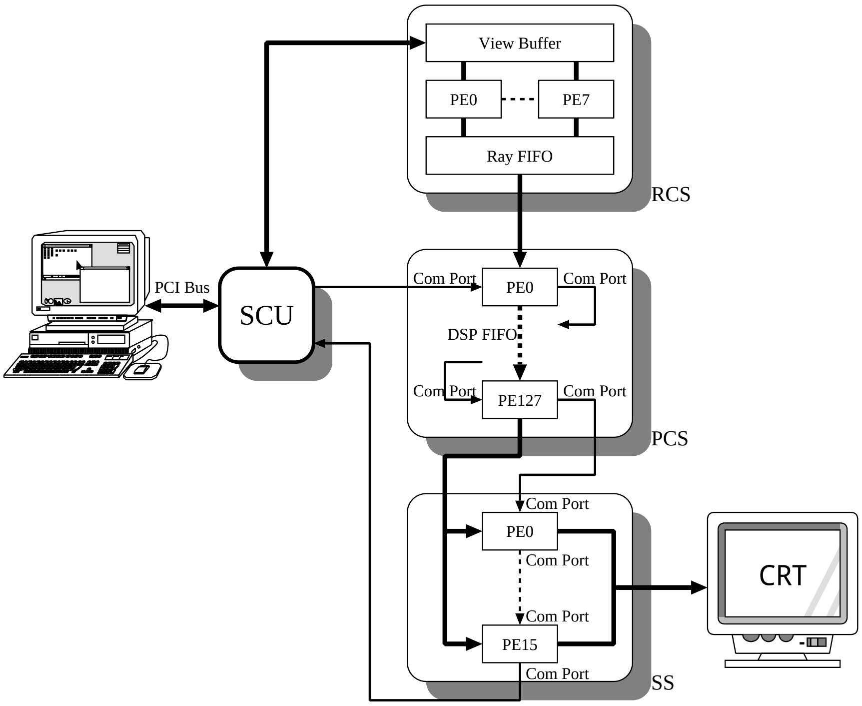
1) 1word=4byte



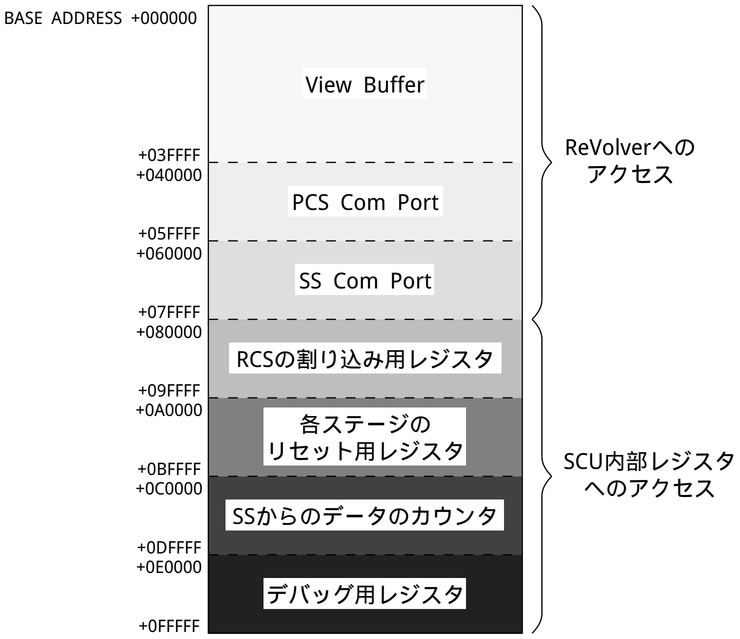
?^3.2: *ReVolver*/C40 Fb$N%G!<%?$NN.$1

Buffer $r2p$7$F%G!<%?$NAw<u?.$r9T$&!#SCU $HPCS $*$h$SSS HO!"2<oN'$N %G!<%?$NAw<u?.$NJ}<0$,B8:_9k!#Bh1 $NJ}K!$O!"Com Port $rMQ$$$?%j%s%0 $rMQ$$$kJ}K!G"$k!#$3$NJ}K!$G$O!"G$0U$NPE XN%G!<%?Aw<u?.$O!"SCU $H BP>]$HJkPE $N4V$KB8:_9kPE $r7PM3$7$F9T$olk!#Bh2 $NJ}K!$O!"2hA| @8@.=hM};~K*$$$F!";k@~%G!<%?$*$h$S%T%/%;%kCM$rE>Aw9kFIFO 7O$N7PO) $rMQ$$$kJ}K!G"$k!#$3$NJ}K!$G$O!"PCS $*$h$SSS XN%G!<%?$NAw?.N_$, 2DG=G"$k!#

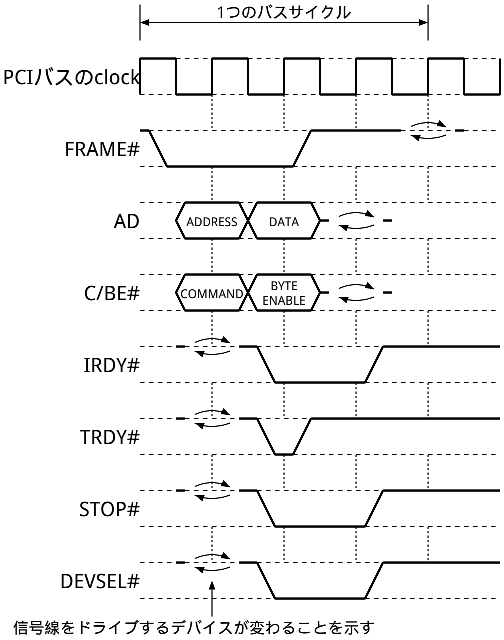
3.3.2 PCI %P%9%$%s%?%U%'!<%9

PCI %P%9$O!"B?=E2=$7$?%"%I%l%9$*hS%G!<%?· %i%$%s$r;}$D9b@-G=$J%P%9 G"$k!#PCI K*1k4pK\E*$J%P%9E>Aw%a%+%K%:%'$O%P%9%5%$%/%kG"$k!#l DN%P%9%5%$%/%k$O!"l 2s$N%"%I%l%9· %U%'!<%:$H1 2s0J>e$N%G!<%?· %U%'!<%: $+$i9=@.5l$k!#

%[%9%H%^%7%s$+$i *ReVolver*/C40 XN%"%/%;%9$O!"PCI %P%9>e$N%a%b%j%"%/ %;%9$G<B8=$9$k!#View Buffer!"PCS!"SS $NCom Port!"SCU $NFbIt%l%8%9%?$r ?^3.3Nh$&$K!"%[%9%H%^%7%s$N%a%b%j6u4V$K%^%C%T%s%0$7!"*ReVolver*/C40 $N @)8f$rSCU $NFbIt%l%8%9%?$X$N%i%$%H$G!"SCU $NFbIt>uBV$N4F;k$rFbIt%l%8



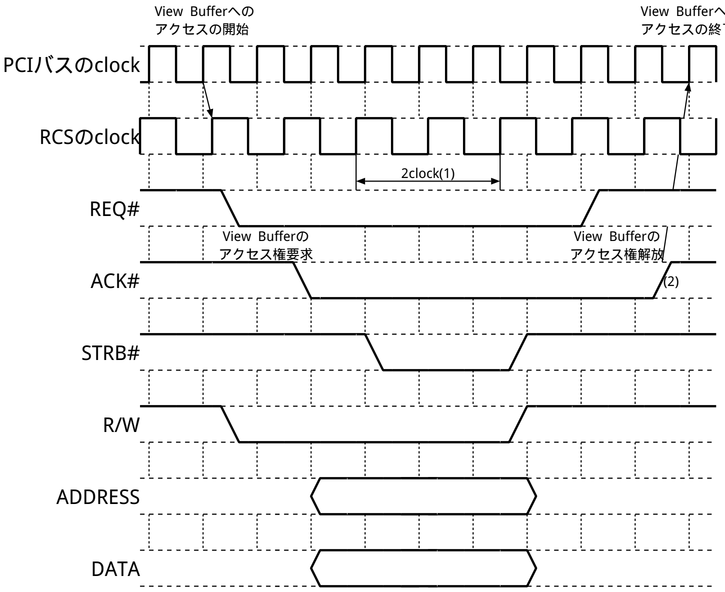
?^3.3: %[%9%H%^%7%s$N%a%b%j%^%C%W



?^3.4: PCI %P%9$N%i%$%H%5%$%/%k

%9%?$N%j!<%I$G$=$l$>$l<B8=9k!#

PCI %P%9$N%i%$%H%5%$%/%k$G$O!"SCU Fb$NE>Aw%P%C%U%!XN%i%$%H$N$_$r9T$&!#1 DN%P%9%5%$%/%k$r1word $NE>Aw$G=*N;9kH-KO!"?^3.4$K<($9h&



?^3.5: View Buffer XN%i%$%H%5%$%/%k

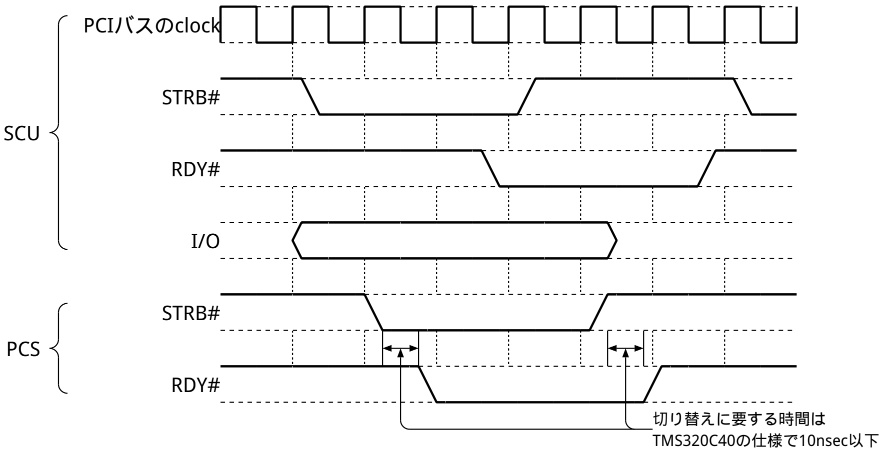
$K!"PCI %P%9$N%i%$%H%5%$%/%k$O4 %/%m%C%/$rI,MWH9$k!#%i%$%H%5%$%/%k$N>l9g!"1 DN%P%9%5%$%/%kFb$GO"B3$7$F%G!<%?$NE>Aw$r9T$&$H$-$K$O!"Kh%/%m%C%/%G!<%?E>Aw$r9T$&$3H,G-$k!#

1 DNPCI %P%9%j!<%I%5%$%/%k$G1word $NE>Aw$N$_$r9T$&>l9g!"SCU Fb$NE>Aw%P%C%U%!$r%j!<%I$9k?aK!"6 %/%m%C%/rI,MWH9k!#1 DN%P%9%5%$%/%kFb$GE>Aw$,O"B3$9kH$-$K$O!"2 %/%m%C%/Kh$K%G!<%?$r%j!<%I$9k3H,G-$k!#

3.3.3 *ReVolver*/**C40** $N3F%9%F!<%8$H$N%$%s%?%U%'!<%9

1. **RCS** %$%s%?%U%'!<%9

   View Buffer XN%"%/%;%9$O!"View Buffer $ND4Dd5!9=$H%?%$%_%s%0$r9go;k?aK!"?^3.5Nh$&$K!"RCS $N%/%m%C%/$GF14|7F9T$&!#RCS $OView Buffer XN%"%/%;%9$,40N;7?$3Hr<($9?.9f$rSCU KJV5$J$$!#$=$3$G!"%"%/%;%9$r@5$7$/9T$&$?$a!"Ev3:%5%$%/%kKOSCU $G>iD9%5%$%/%k$,A^F~$5lk!#View Buffer $K%i%$%H$r9T$&H-KO!"2 %/%m%C%/$N4V%G!<%?$r=PNO$7B3$1$k(?^3.5$N(1))!#%j!<%I;~$O!"SCU $,=PNO$7$?%j!<%I$NMW5a$NCY1d$H!"View Buffer $+$i$N%G!<%?$NCY1d$r9MN8$7$F!"View Buffer XN%j!<%I$NMW5a$+$i3 %/%m%C%/8e$N%G!<%?$rM-8z$H9k!#$^$?!"SCU $,View Buffer XN%"%/%;%9$r=*N;$9kH$-KO!"SCU $,View Buffer $N%"



?^3.6: PCS XNAw?.%5%$%/%k

%/%;%9$N8"Mx$r2rJ|9kI,MW$,$"$k(?^3.5$N(2))!#hC$F!"View Buffer XN%j!<%I/%i%$%H$,A4$F40N;$9kN$O!"View Buffer $ND4Dd5!9=$,SCU $N View Buffer XN%"%/%;%9$,40N;7?$3HrCNC?8eG"$k!#RCS FbGO!"SCU $N%j!<%I%5%$%/%k$O1word $"$?$j:GC;$G3%/%m%C%/!"%i%$%H%5%$%/%k$O:GC;$G2%/%m%C%/$G9T$olk!#

2. **PCS/SS** %$%s%?%U%'!<%9

   Com Port $rMQ$$$?%G!<%?E>AwGO!"%O%s%I%7%'%$%/$r9T$&!#$3$NJ}K!$G$N%G!<%?E>Aw;~$K$O!"SCU $N%a%$%s%\!<%I$HPCS $*$h$SSS $,J*M}E*$KN%lF$$$k$?$aKI,MWJDL?.%W%m%H%3%k$N%*!<%P%X%C%I$H!"DSP $,HsF14|$K%O%s%I%7%'%$%/$r9T$&$NKBP7$F!"SCU $,PCI %P%9$N%/%m%C%/$KF14|$7$F%O%s%I%7%'%$%/$r9T$&3HKh$k%*!<%P%X%C%I$,B8:_9k!#hC$F!"?^3.6$K<(9h$&$K!"Com Port $rMQ$$$F1%P%$%H$N%G!<%?$NE>Aw$r9T$&$?aK!"6%/%m%C%/rI,MWH9k!#

3.3.4 4pK\%W%j%_%F%#%V

SCU $,%[%9%H%^%7%s$KBP7FDs6!9k4pK\%W%j%_%F%#%V$O0J2<$N5DG$"$k!#

View Buffer %i%$%H

%[%9%H%^%7%s$+$i$NView Buffer %i%$%H%5%$%/%k$O2DN%U%'!<%:$+$iJk!#%[%9%H%^%7%s$,SCU Fb$NE>Aw%P%C%U%!$K%G!<%?$r=q$-9~$`PCI %i%$%H%U%'!<%:$H!"E>Aw%P%C%U%!$K=q$-9~$^$l$?%G!<%?$rView Buffer $X=q$-9~$`%U%'!<%:G"$k!#View Buffer $ORCS Fb$NA4PE HN4V$G6&M-$9k?$a!"%"%/%;%9$K:]$7D4Dd5!9=$K%"%/%;%98"$rMW5a$9kI,MW,$"$k!#7+7J$,$i!"

%[%9%H%^%7%s$O8e<T$N%U%'!<%:$N4ON;$rBTDI,MW,$J$$$?$a!"View Buffer %i%$%H$OSCU Fb%P%C%U%!$K%G!<%?$r=q$-9~s@;v<B$G8+$+$1>e=*N;$9$k!#

View Buffer %j!<%I

View Buffer %j!<%I%5%$%/%k$O!"PCI %j!<%I%5%$%/%k$N3+;O%U%'!<%:!"View Buffer %j!<%I%U%'!<%:!"PCI %j!<%I%5%$%/%k$N=*N;%U%'!<%:$N3 DN%U%'!< %:$+$iJk!#PCI %j!<%I%5%$%/%k$,H/@8$9kH!"SCU $OD4Dd5!9=$K%"%/%; %98"$rMW5a$7!"View Buffer XN%j!<%I$r9T$&!#1 DNPCI %j!<%I%5%$%/ %k$G!"%j!<%IMW5a$,O"B3$7$FH/@8$9kH!"SCU $OFPGA Fb$GJ];}9k%" %I%l%9NCMr%$%s%/%j%a%s%H$7!"O"B3$7$FView Buffer XN%j!<%I$r9T$&!# %[%9%H%^%7%s$,PCI %j!<%I%5%$%/%k$r=*N;$9kH!"SCU $OView Buffer $N %"%/%;%98"$r2rJ|$7!"View Buffer %j!<%I%5%$%/%k$r=*N;$9$k!#

PCS %i%$%H

PCS %i%$%H%5%$%/%k$O!"View Buffer %i%$%H%5%$%/%k$HF1MM$K!"E>Aw%P%C %U%!$X$NPCI %i%$%H%U%'!<%:$H!"Com Port XNAw?.%U%'!<%:$N2 DN %U%'!<%:$+$iJk!#PCI %i%$%H%U%'!<%:$HHf3S7F!"Com Port XNAw?. %U%'!<%:$OB?$/$N;~4V$rI,MWH9k,!"Com Port GN%G!<%?$NAw?.$N4ON; $r%[%9%H%^%7%s$,BT$DI,MW$O$J$$!#hC$F!"%[%9%H%^%7%s$OE>Aw%P%C%U%! $K%i%$%H$r4ON;$9k@1G!"PCS %i%$%H%5%$%/%k$r8+$+$1>e=*N;$9$k!#

SS %j!<%I

PCS $HSS $NDSP $+$i%G!<%?$r<u?.$9k?$a!"0J2<$N<j=g$rMQ$$$k!#

1. %[%9%H%^%7%s$,%j!<%I$7$?$$%G!<%?$rJ];}$9$kDSP $K%G!<%?$NMW5a$r 9T$&!#$3$1$O!"Com Port $N%j%s%0$rMQ$$$F9T$&!#
2. MW5a$r<u$1<hC?DSP $OCom Port $N%j%s%0$rMQ$$$FSCU $K%G!<%? $rAw?.$9$k!#
3. %[%9%H%^%7%s$OSCU Fb$N%l%8%9%?$r;2>H$9k3HG!"SS $+$iSCU $K %G!<%?$,Aw?.5l$?$+rCNk3H$,$G$-!"Aw?.$5lk$^$GBT$D!#
4. %[%9%H%^%7%s$,SCU Fb$N%G!<%?$r%j!<%I$9$k!#

1HVL\$N<j=g$OPCS %i%$%H%5%$%/%k$HDSP 4VGNCom Port DL?.$rMQ$$$F 9T$&!#3HVL\$N<j=g$O<!$K=RYkSCU %l%8%9%?%"%/%;%9%5%$%/%k$rMQ$$$F 9T$&!#SS %j!<%I%5%$%/%k$O!"2HVL\$N<j=gK*1kSS $+$iSCU XN%G!< %?E>Aw%U%'!<%:$H!"4HVL\$N<j=gK*1kPCI %j!<%I%U%'!<%:$r<B9T$9$k!# SS $+$iSCU XN%G!<%?E>Aw$HPCI %P%9$G$N%j!<%I$O!"8_$$$KE>Aw%P%C%U%!

KBP7$FFHN)$K<B9T5l$k!#

SCU %l%8%9%?%"%/%;%9

SCU %l%8%9%?%"%/%;%9%5%$%/%k$O!"PCI %j!<%I%U%'!<%:b7$/$OPCI %i%$%H%U%'!<%:$N$_$+iJ$k!#SCU Fb$N%l%8%9%?$K%i%$%H$r9T$&3H$G!"ReVolver/C40 $N@)8f$r9T$$!"SCU Fb$N%l%8%9%?$r%j!<%I9k3H$G!"SCU $N>uBV$r4F;k9k!#

3.4 SCU $r2p$7$?*ReVolver*/C40 $N@)8f

3.4.1 3F%9%F!<%8$NDSP $N%V!<%H

RCS : 6&M-%a%b%j%V!<%HJ}<0

RCS $NDSP $OView Buffer $+$i%V!<%H%W%m%0%i%`$r%j!<%I$9$k!#RCS $NDSP $O%j%;%C%H$r9T$C$?D>8e$K!"%V!<%H%W%m%0%i%`$N%j!<%I$r9T$&$N$G!"RCS Fb$NDSP $r%V!<%H$9k?aK!"View Buffer XN%V!<%H%W%m%0%i%`$N%i%$%H$N8e$G!"RCS $N%j%;%C%H$r9T$&!#View Buffer $O!"A4$F$NRCS Fb$NDSP $G6&M-$5lF$$$k$?$a!"3NJ}K!$GRCS Fb$NA4FNDSP $N%V!<%H$r9T$&$3H,G-$k!#

PCS : C`<!E*<+8JJ#@=%V!<%HJ}<0

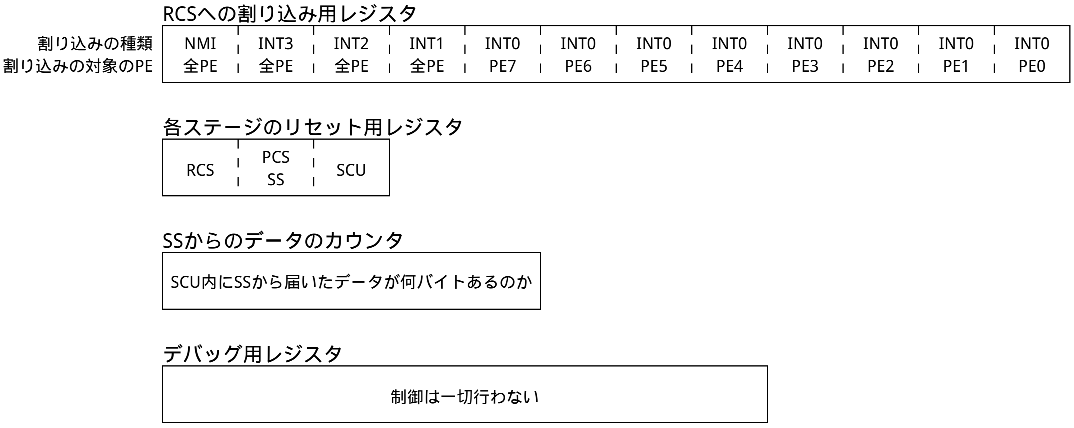
SCU $OPCS $N@hF,$NDSP $rCom Port $rMQ$$$F%V!<%H9k!#PCS $N@hF,$NDSP $O!"%V!<%H%W%m%0%i%`$N%3%T!<$rAw?.$9k3HKhj!"<!$K@\B3$5l?DSP $r%V!<%H$9$k!#$3lHF1MM$K!"%V!<%H$r=*$($?DSP $,!"%V!<%H$N4ON;7F$$$J$$<!$K@\B3$5l?DSP $r%V!<%H$9k3HG!"PCS Fb$NA4$F$NDSP $r%V!<%H$9$k!#

SS : PCS %P%$%Q%9+C`<!E*<+8JJ#@=%V!<%HJ}<0

SS Fb$NDSP $N%V!<%H$O!"PCS Fb$NA4DSP $N4ON;$N8e$K9T$olk!#SS $N%V!<%H%W%m%0%i%`$r!"Com Port $N%j%s%0$rMQ$$$FSS $N@hF,$NDSP $KAw?.$7!"SS $N@hF,$NDSP $N%V!<%H$r9T$&!#0J9_$OPCS $G$NJ}K!$HF1MM$K!"%V!<%H$N4ON;$7$?DSP $,!"%V!<%H%W%m%0%i%`$N%3%T!<$rAw?.$9k3HKhj!"<!$K@\B3$5l?DSP $r%V!<%H$9$k!#$3$N<j=g$r7+jJV7!"SS Fb$NA4$F$NDSP $r%V!<%H$9$k!#

3.4.2 *ReVolver*/C40 $N3F%9%F!<%8$N@)8f

%[%9%H%^%7%s$+$i9T$&*ReVolver*/C40 $N@)8f$H7F!"RCS XN3d$j9~$_!"RCS!"PCS!"SS!"SCU $N%j%;%C%H$,$"$k!#$^$?!"3F%9%F!<%8$K@5$7$$0IA j$N%/%m%C%/



?^3.7: SCU $NFbIt%l%8%9%?

$r6!5k$9kI,MW,$"$k!#

RCS XN3d$j9~$_$H3F%9%F!<%8$X$N%j%;%C%H$O!"SCU FbIt$N%l%8%9%?$K%i%$%H$9k3HG<B8=9k!#6qBNE*KO!"?^3.7Nh$&$KSCU FbIt$KRCS XN3d$j9~$_MQ$N%l%8%9%?!"3F%9%F!<%8$N%j%;%C%HMQ$N%l%8%9%?$r@_$1!"RCS $N3d$j9~$_MQ$N%l%8%9%?$N3F%S%C%H$K$ORCS XN3d$j9~$_$N<oN`!"3d$j9~$_$r9T$&PE $rBP1~$5$;$k!#$^$?!"3F%9%F!<%8XN%j%;%C%HMQ%l%8%9%?KO!"3F%S%C%H$K3F%9%F!<%8$rBP1~5;$k!#$?$@$7!"PCS $HSS $OCom Port $N%j%s%0$G$N%G!<%?E>Aw$r9T$&$?$a!"F1$8%S%C%H$G%j%;%C%H$r9T$&!#%[%9%H%^%7%s$,MW5a9k=hM}$KBP1~$7$?%S%C%H$r1 H7$?%G!<%?$r!"%l%8%9%?$K%i%$%H9k$H!"SCU O=lrbH$KReVolver/C40 $N@)8f$r9T$&!#$=$N8e3F=hM}$,=*N;9k$H!"SCU $O<+F0E*$K%l%8%9%?$r0 $K%/%j%"$9$k!#

%j%;%C%H$N2r=|$O!"3F%9%F!<%8$GF1;~$K9T$&I,MW$,$"$k!#hC$F!"%/%m%C%/$r@8@.7F$$$k%5%V%\!<%I$r7PM3$7!"%/%m%C%/$HF14|$r<hk3HGF1;~$K9T$&!#

3.4.3 3F<o%G!<%?E>Aw

SCU $+$iReVolver/C40 $N3F%9%F!<%8$X$HE>Aw$9$k%G!<%?$O4 D"$k!#0J2<$K$=$l$>$lKD$$$F=RYk!#

- %S%e!<%G!<%?

  I=3.1$K<($9h&$J9=B$$N%S%e!<%G!<%?$r RCS Fb$N View Buffer $K3JG<$9$k!#

- %\%j%e!<%`%G!<%?

  ReVolver/C40 GO%\%/%;%kCM$O!"?'!\F)L@EY$K4X9kB0@-%F!<%V%kXN%$%s%G%C%/%9$G$"$k!#%\%/%;%kCM$O!"1byte $GI=$o5l$F$$$k$?$a%\%j%e!<%`

I=3.1: %S%e!<%G!<%?$N%U%)!<%^%C%H

%G!<%?L>	%G!<%?%5%$%:	FbMF
;kE@ $\vec{E}$	32-bit float × 3	%o!<%k%I:BI87OK*1k;kE@$N:BI8!#
%9%/%j!<%s $\vec{S}_v$	32-bit float × 3	%9%/%j!<%s$N?bD>J}8~$NC10L%Y%/%H%k
$\vec{S}_h$	32-bit float × 3	%9%/%j!<%s$N?eJ?J}8~$NC10L%Y%/%H%k
$\vec{S}_b$	32-bit float × 3	;kE@$+$i%9%/%j!<%s$N:8>eD:E@$X$N%Y%/%H%k

%G!<%?$O!"$512^3$byte(=128Mbyte) $N%G!<%?$G$"$k!#PCS $O%[%9%H%^%7%s$+$i%\%j%e!<%`%G!<%?$r<u?.$7!"3FPCU Fb$N%\%j%e!<%`%a%b%j$K3JG<9k!#%\%j%e!<%`%G!<%?$NE>Aw$O3.2.1@a$G=R$Y$?$h$&$K!"FIFO 7O$N7PO)$rMQ$$$F9T$&!#

- ?'·F)L@EY$N%F!<%V%k

  ?'·F)L@EY$N%F!<%V%k$OI=3.2Nh$&$J9=B$$r7F$*$j!"PCS $N3FDSP $NFbIt%a%b%j$K3JG<9k!#%\%/%;%kCM$O1byte $GI=$5lF$$$k$?$a!"3N%F!<%V%k$O256%(%s%H%j$G9=@.5l$k!#$hCF!"3N%F!<%V%k$N%5%$%:$O4kbyte G"$k!#

I=3.2: ?'!&F)L@EY$N%F!<%V%k$N%U%)!<%^%C%H

%G!<%?L>	%G!<%?%5%$%:	FbMF
?' $c(v_i)$	32-bit float × 3	%\%/%;%k$N?'!#RGB $N3MWAG$GI=o5lk!#
F)L@EY $\alpha(v_i)$	32-bit float	%\%/%;%k$NF)L@EY!#CM$,Bg$-$$DxF)L@!#

- 8w8;$N%G!<%?

  8w8;H7$FJ?9T8w8;$rA[Dj7F$$$kNG!"8w8;$K4X$9$k%Q%i%a!<%?$O!"I=3.3Nh$&$K?'$HJ}8~$N2DG9=@.5l$k!#8w8;$N%G!<%?$OSS $N3FDSP $NFbIt%a%b%j$K3JG<9k!#8w8;%G!<%?$N%5%$%:$O24byte G"$k!#

I=3.3: 8w8;$N%G!<%?$N%U%)!<%^%C%H

%G!<%?L>	%G!<%?%5%$%:	FbMF
?' C_l	32-bit float × 3	8w8;$N?'!#RGB $N3MWAG$GI=o5lk!#
J}8~ $\vec{D}_l$	32-bit float × 3	8w8;$+$i%\%j%e!<%`6u4VXNJ}8~%Y%/%H%k!#

$3$3$G!"?'·F)L@EY$N%F!<%V%k$NE>AwJ}K!$K$D$$$F9M$($k!#PCS $HSS XN%G!<%?$NE>AwJ}K!$O!"3.3.1@a$G=RY?h&$K!"Com Port $N%j%s%0$rMQ$$$?J}

K!$H!"FIFO 7O$N7PO)$rMQ$$$kJ}K!$,$"$k!#

FIFO 7O$N7PO)$rMQ$$$k>l9gKO!"PCS $NPE $OFIFO Fb$N%G!<%?$N<oJLH=Dj$r9T$&I,MW$,$"$k!#7+$7!"%G!<%?$NE>Aw$r1 %U%l!<%`$N2hA|@8@.=hM}$r9T$C$F$$$k4VKO9ToJ$$$3HKhj!"H=Dj$N2s?t$r8:>/$7H=Dj;~4V$r1#JC9k!#PCS Fb$NDSP B&$HAddress Generator B&$N2 7OE}$N%G!<%?$NN.$1O=1>1,F1$8$@1N%G!<%?$rA0$NPCU $+$i<u?.9k$?$a!"DSP B&$NFIFO $r;HMQ$9kH$-$K$O!"Address Generator KbE,Ev$J=hM}$r9T$&I,MW$,$"$k!#

0lJ}Com Port $N%j%s%0$rMQ$$$k>l9gKO!"PCS $N2hA|@8@.=hM}$X$NlF6A$O$J$$!#

hC$F!"Com Port $N%j%s%0$rMQ$$$?E>Aw;~4V$,!"2hA|@8@.=hM}$KMW9k;~4V$Kl F6A$,$J$$$H$-$K$O!"Com Port $N%j%s%0$rMQ$$$F%G!<%?$NE>Aw$r9T$&$Y$-$G$"$k!#0J2<GO!"Com Port $N%j%s%0$rMQ$$$?%G!<%?E>AwKMW9$k;~4V$K$D$$$F=RYk!#

Com Port $N%j%s%0$rMQ$$$F%G!<%?$NE>Aw$r9T$&$H!"DSP $N=hM}$K3d$j9~$_$,$+$+$k!#TMS320C40 GO3d$j9~$_;~$N%l%8%9%?$NB`Hr$K43 %/%m%C%/$rMW$9$k!#PCS $NF0:n%/%m%C%/$r25MHz $H$9$k$H!"PCS $NA4DSP128 Bf$KC`<!E*$K3d$j9~$_$r9T$&$?$a!"

$$128 \times 43(clock) \times 40(nsec) = 220(\mu sec)$$

$N=hM};~4V$rI,MWH9$k!#$^$?!"3.3.3@a$G=RY?h&$K!"SCU $OCom Port $rMQ$$$F1byte $N%G!<%?$rAw?.9k$?$a$K!"6 %/%m%C%/$rI,MWH9$k!#$hCF!"SCU $NF0:n%/%m%C%/$r33MHz H9kH!"4kbyte $N%G!<%?$NE>AwKO!"

$$4096 \times 6(clock) \times 30(nsec) = 737(\mu sec)$$

$N;~4V$rMW9k!#hC$F!"?'·F)L@EY$N%F!<%V%k$NE>Aw;~4V$O!"

$$220(\mu sec) + 737(\mu sec) = 957(\mu sec)$$

G"$k!#$7$+$7!"1 %U%l!<%`$N2hA|@8@.$KMW9k;~4V$O!"398msec [3] $H?'·F)L@EY$N%F!<%V%k$NE>Aw;~4V$N$*$h$=400 G\$G$"$k!#hC$F!"Com Port $rMQ$$$??'·F)L@EY$N%F!<%V%k$NE>Aw;~4V$O2hA|@8@.=hM}$K1F6A$rM?$($J$$!#f($K!"?'·F)L@EY$N%F!<%V%k$NAw?.$K$OCom Port %j%s%0$rMQ$$$k!#

8w8;%G!<%?$NE>Aw$O!"?'·F)L@EY$N%F!<%V%k$HHf3S7F!"3d$j9~$_$NH/@8$9$kDSP $N?t$OA}$($kbN$N!"%G!<%?$N%5%$%:$,24byte G"kN$G!"%G!<%?$NAw?.KMW9$k;~4V$O?'·F)L@EY$N%F!<%V%k$NE>Aw;~4Vhj$bC;$$!#hC$F!"8w8;%G!<%?$NE>AwKbCom Port %j%s%0$rMQ$$$k!#

3.4.4 %f!<%6%$%s%?!<%U%'!<%9

%[%9%H%^%7%s>e$N%W%m%0%i%`$ODL>o%b!<%I$H%G%P%C%0%b!<%I$N2 DL$j$NF0:n%b!<%I$r;XDj$G$-$k!#DL>o%b!<%I;~$N%[%9%H%^%7%s>e$N%W%m%0%i%`$NF0:n$NN.$l$OO J2<$NDLjG$"$k!#

1. *ReVolver*/C40 $N5/F0
2. =i4 |%G!<%?$NE>Aw
3. %Q%i%a!<%?$NJQ99

ReVolver/C40 A4BN$N%G%P%C%0$N$_$Ji:!"8DJL$N%9%F!<%8$N%G%P%C%0KbBP1~9k$?$a!"%G%P%C%0%b!<%IGOA4FNA`:n$r<jF0$G9T$&!#0J2<$K!"3liK$D$$$F=RYk!#

ReVolver/**C40** $N5/F0 *ReVolver*/C40 $rJ#?t$N%f!<%6$,;HMQ$9k3HOG-$J$$$N$G!"%^%k%A%f!<%64D6-$G$N;HMQ;~$K$O!"*ReVolver*/C40 $r%m%C/$9kI,MW,$"$k!#PCI %P%9>e$G%O!<%I%&%'%"E*$K%m%C/9kNGOJ$/!"%[%9%H%^%7%s>e$N%W%m%0%i%`$,%=%U%H%&%'%"E*$K%m%C/9k!#

$=$N8e!"*ReVolver*/C40 $N%V!<%H$r9T$&!#$3lO!"*ReVolver*/C40 A4BN$N%j%;%C%H$r9T$$!"SCU $r7PM3$7$F%V!<%H%W%m%0%i%`$r3F%9%F!<%8$KE>Aw$7!"RCS C1BN$N%j%;%C%H$r9T$&$3$H$G<B8=$9$k!#$3$l$i$N=hM}$O!"%f!<%6$,0U<1$7$F9T$&$N$G$O$J$/!"%W%m%0%i%`$N5/F0;~$K<+F0E*$K9T$&!#

=i4 |%G!<%?$NE>Aw %S%e!<%G!<%?!"%\%j%e!<%`%G!<%?!"?'·F)L@EY$N%F!<%V%k!"8w8;%G!<%?$N=i4 |CM$r%f!<%6$,;XDj$7!"$=lrAw?.9k3H$G!"*ReVolver*/C40 $N=i4 |2=$r9T$&!#

%Q%i%a!<%?$NJQ99 3F%Q%i%a!<%?$K$D$$$F$=$l$>$l0J2<$K=R$Y$k!#

1. %S%e!<%G!<%?

   8=:_CRT $KI=<($5lF$$$k2hA|$NJ?9T0\F0!"2sE>!"3HBg·=L>.$r%f!<%6$,;XDj9k$H!"%[%9%H%^%7%s>e$N%W%m%0%i%`$O!"8=:_$N%S%e!<%G!<%?$+$i?7$7$/%S%e!<%G!<%?$r:n@.$7!"*ReVolver*/C40 $X$HAw?.$9$k!#*ReVolver*/C40 $G$O!"$=$N%S%e!<%G!<%?$r$b$H$K2hA|$r@8@.$7!"SS $,1%U%l!<%`$N2hA|@8@.$N=*N;$rSCU $KDILCN$9$k!#%[%9%H%^%7%s>e$N%W%m

%0%i%`$O!"SS $+$i$N2hA|@8@.$N=*N;$NDILCN$rBTCF<!$N%S%e!<%G!<%? $rAw?.$9$k!#$3$N<j=g$rMQ$$$kM}M3$O!"%S%e!<%G!<%?$NJQ99$,IQH/$9 kH!"2hA|@8@.=hM}$,4V$K9go:!"$=$N7k2LH7$F@8$8$k View Buffer Fb$NL58z$J%G!<%?$NC_@QrKI0$?$aG"$k!#

2. ?′·F)L@EY$N%F!<%V%k

   ?′·F)L@EY$N%F!<%V%k$O!"A4FNJQ99$r=*N;$7$?8e$K0l3g7FAw?.$9 Y-%G!<%?G"$k!#$hCF!"%[%9%H%^%7%s>e$N%W%m%0%i%`$O%f!<%6$, JQ99$r=*$($kNrBT$A!"?′·F)L@EY$N%F!<%V%k$rAw?.9k!#

3. 8w8;%G!<%?

   8w8;%G!<%?$NJQ99$O%S%e!<%G!<%?$NJQ99$HF1MM$K!"JQ99$5l?;~E@$G *ReVolver*/C40 XHAw?.9k!#JQ99$5$l$?%G!<%?$rMQ$$$?2hA|@8@.$N=* N;$N8e$K!"<!$N8w8;%G!<%?$rAw?.$9$k!#

4. %\%j%e!<%`%G!<%?

   %\%j%e!<%`%G!<%?$OE>Aw7PO)$N@-<A>e!"2hA|@8@.=hM}$r9T$C$F$$$k4V $K$OE>Aw$9$k$3$H$,$G$-$J$$!#$h$C$F!"SS $OMW5a$K1~$8$F!"8=:_2hA| @8@.=hM}Cf$G$"$k$+$I$&$+$r<($9%G!<%?$r SCU $KAw?.$9$k!#%[%9%H %^%7%s$O$=$N%G!<%?$r%j!<%I$7!"8=:_=hM}Cf$G$J$$$3$H$r3NG'$7$F$+ $i!"%\%j%e!<%`%G!<%?$NE>Aw$r3+;O9k!#

%G%P%C%0%b!<%I　%G%P%C%0;~KO!"3F%9%F!<%8$NC1BN$G$N%G%P%C%0!"2 DN%9 %F!<%84V$N%G%P%C%0!"*ReVolver*/C40 A4BN$N%G%P%C%0$,9M$($ilk!#SCU $N %a%$%s%\!<%IOI$N>u67$K$*$$$F$b@\B32DG=$J9=@.HJCF$$$kNG!"%[%9%H%^%7%s>e$N%W%m%0%i%`$O$=$NA4FN>u67$KBP1~$9kI,MW,$"$k!#hC $F!"%G%P%C%0%b!<%I$G$O!":G=i$KIN%9%F!<%8$HSCU $,@\B3$5lF$$$k$N $+$r%f!<%6$,;XDj$7!"SCU $H@\B3$5lF$$$k%9%F!<%8N_$N5/F0$r9T$&!# $^$?%G%P%C%0;~KO!"A4FN%G!<%?E>Aw$r<jF0$G9T$&!#

4 %\%j%e!<%`%G!<%?$NE>Aw

8=:_$N9=@.$N RCS!"PCS!"SS $*$h$S SCU K*$$$F!"%\%j%e!<%`%G!<%?$NE> AwJ}K!$K$D$$$F9M;!$r9T$&!#$=$N7k2L$r$b$H$K!"%\%j%e!<%`%G!<%?$NE>Aw;~4V $r7W;;$7!"$=$N7W;;2aDx$HK\SCU $N@_7W$+$i8=:_$N *ReVolver*/C40 KD$$$F9M ;!$r9T$&!#

4.1 %\%j%e!<%`%G!<%?$N3 =E2=

ReVolver/C40 GO%\%j%e!<%`%G!<%?$r3 =E2=$7$F5-21$7$F$$$k!#$h$C$F!"%[%9%H%^%7%s$+$iPCS Fb$N%\%j%e!<%`%a%b%j$K3JG<$9k^GN$$$:l+$N;~E@$G!"%\%j%e!<%`%G!<%?$r3 =E2=$9kI,MW,$"$k!#

SCU hjAwil$?3 =E2=$5lF$$$J$$%\%j%e!<%`%G!<%?$NI,MW$J%\%/%;%k$r!"PCS $N3FPE $,H=CG$7!"%\%j%e!<%`%a%b%j$N@5$7$$0LCV$K3JG<$9$kJ}K!$,!"A4BNH7F_$?$H$-$K!"%\%j%e!<%`%G!<%?$NE>Aw;~4V$rC;$/$9k3H,G-$k!#M}M3$r0J2<$K=R$Y$k!#

%\%j%e!<%`%G!<%?$NE>Aw%W%m%H%3%k$K$h$j!"PCS Fb$NPE $O<!$K3JG<$9$Y$-%\%/%;%k$r2?word 8e$K<u?.$9$k$+$rCN$k$3$H$,$G$-$k!#$h$C$F!"%\%/%;%k$r<u?.$9$kKh$K3JG<$9$Y$-$+$I$&$+$rH=CG$9$kI,MW$,$J$/!"PCS Fb$G3 =E2=$r9T$&$?$a$KMW$9$k;~4V$O$J$$!#$^$?!"%\%j%e!<%`%G!<%?$NE>Aw$K$OFIFO 7O$N7PO)$rMQ$$$k!#PCS Fb$G3 =E2=$r9T$&$H!"3N7PO)GO3 =E2=5l$F$$$J$$%\%j%e!<%`%G!<%?$rE>Aw$9k3HKJj!"3 =E2=7F$+$iE>Aw9kJ}K!hj$b!"E>Aw;~4V$rC;=L9k3H$,$G$-$k!#

4.2 %\%j%e!<%`%G!<%?$NE>Aw;~4V

%[%9%H%^%7%s$+$iSCU XOPCI %P%9$rMQ$$$F%G!<%?$NE>Aw$,9Tol$k!#PCI %P%9$G$O%G!<%?$NE>Aw$rKh%5%$%/%k9T$&$3H,G-$k!#

8=:_$NRCS $N9=@.$G$O!"SCU $HRCS $NPE $,F1;~$KView Buffer $X%"%/%;%9$9k3HOG-$J$$!#SCU $,RCS $NView Buffer $X%i%$%H$r9T$&:]KO!"D4Dd5!9=$+$i%"%/%;%9$N8"Mx$rM?$($ilkI,MW$,$"k,!"3N=hM}KMW9$k;~4V$N1F6A$rL5$/9?$a!"View Buffer $X9T$&%i%$%H$N%G!<%?$NC10L$OBg$-$/9k!#View Buffer XN%"%/%;%9KMW9$k;~4V$O!"SCU $,2%/%m%C%/!"RCS $,2%/%m%C%/$G$"$k!#0lJ}!"RCS $NPE $,Ray FIFO Buffer $K%i%$%H9kNKMW9k;~4V$OPE KhCF0[Jj!"4%/%m%C%/b7$/$O5%/%m%C%/G"kN$G!"PE $,Ray FIFO Buffer $K%i%$%H9k$?$a$K!":GDc4%/%m%C%/$OI,MWG"$k[2]!#$3liN&$A!"PE $NRay FIFO Buffer XN%i%$%H$H!"SCU $NView Buffer XN%i%$%H$OJBNs$K<B9T2DG=$JNG!"RCS $r%\%j%e!<%`%G!<%?$,DL2a9k$?$a$K6%/%m%C%/$rI,MWH9$k!#

PCS Fb$NDSP $O!"FIFO $+$i%G!<%?$r%j!<%I$9k?aK1%/%m%C%/!"FIFO $K%G!<%?$r%i%$%H$9k?aK2%/%m%C%/I,MWH7!"PCS FbGNE>Aw;~4V$O9g7W

3 %/%m%C%/G"$k! #

SCU ! "RCS ! "PCS $OJBNs$K<B9T2DG=JN$G! "0J>e$N7k2Lhj! "RCS GNE>Aw ;~4V$,A4BN$NE>Aw;~4V$r7hDj$9$k! #RCS $NF0:n%/%m%C%/$r 25MHz H9kH! " 1word $NE>Aw$KMW9k;~4V$O! "

$$6(clock) \times 40(nsec) = 240(nsec)$$

G"$k! #A4%\%j%e!<% `%G!<%?(128Mbyte = 32Mword) $NE>Aw$KMW9k;~4V$O! "

$$240(nsec) \times 32(Mword) = 8.05(sec)$$

G"$k! #

3l$O%\%j%e!<% `%G!<%?$NE>Aw$KMW$9$k;~4V$N$_$G$"$j! "<B:]$K$O PCS $N PE $O! "E,@Z$J%\%/%;%k$r%\%j%e!<% `%a%b%j$K3JG<9kNG! "3N7k2Lhj$O<B:]$N%\%j%e!<% `%G!<%?$NE>Aw;~4V$OD9$/$J$k! #

%\%j%e!<% `6u4VFb$NA4%\%/%;%k$r PCS $KAw?.$9$k$?$a$KMW$9$k;~4V$O! "1 %U%l!<% `$N2hA|@8@.$KMW9k;~4V(398msec) N*h=20 G\$G$"$k! #

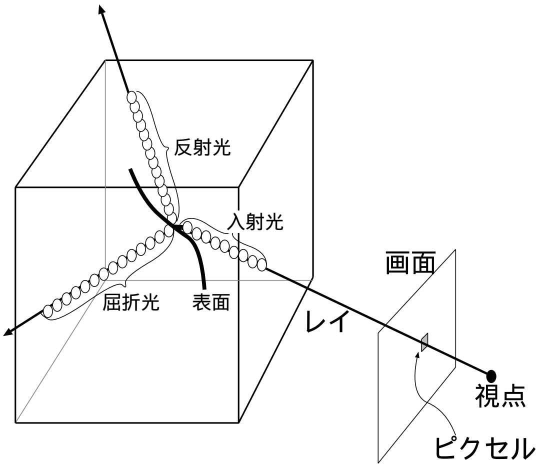
4.3 9M;!

8=:_$N9=@.$N *ReVolver*/C40 GO! "%\%j%e!<% `%G!<%?$NE>Aw$K8.05sec MW9k! # 3l$O *ReVolver*/C40 Fb$N9bB.$JE>Aw7PO)$G$"$k FIFO 7O$N7PO)$,! "RCS $r7PM3$9k+iG$"$j! "SCU $+$i PCS $x FIFO 7O$N7PO)$rMQ0U$9lP! "3N;~4VO5iKC;=L9k3H$,$G$-$k! #

$^$?! "%\%j%e!<% `6u4VFb$NA4%\%/%;%k$NE>Aw;~4V$O 1 %U%l!<% `$N2hA|@8@.=hM}$KMW9k;~4VN*h=20 G\$G$"$k$,! "$9GK *ReVolver*/C40 $N%\%j%e!<% `%a%b%jFb$K3JG<$5$l$F$$k%\%j%e!<% `%G!<%?$H!"?7$7$/Aw?.$r9T$&%\%j%e!<% `%G!<%?$H$NO[$J$k%\%/%;%k$,!"$"$kItJ,6u4VFb$K$N$_B8:_$9$k>l9g$K$O! "%\%j%e!<% `6u4VA4BN$r *ReVolver*/C40 $KE>Aw$9kI,MWOJ/! "$=$NItJ,6u4V$KB0$9$k%\%/%;%k$N$_$NAw?.$r9T$(Ph$$! #FIFO 7O$N7PO)$rMQ$$$?E>Aw;~4V$OE>AwNL$KHfNc9kNG! "3NItJ,6u4VNBg-5,A4%\%j%e!<% `6u4V$N$\frac{1}{20}$ $G$"$k$J$i! "%\%j%e!<% `%G!<%?$NE>Aw;~4V$H 1 %U%l!<% `$N2hA|@8@.;~4V$O$[$\Ey$7$/Jk! #

K\9F$G=R$Y$?SCU $rMQ$$$l$P! "%\%j%e!<% `%G!<%?$rMQ$$$?%l%$%H%l!<%7%s%0 $r<B8=$9k3Hb2DG=G"$k[5] ! #0J2<$K$=$NJ}K!KD$$$F=RYk! #

%\%j%e!<% `%G!<%?$rMQ$$$?%l%$%H%l!<%7%s%0$O! "?^4.1$K<($9h&$K! ";k@~$H



?^4.1: %l%$%H%l!<%7%s%0$NMM;R

I=LL$,8r:9$9kH!"H?<M· 6~@^8w(0J2<9b<!8w$H8F$V) $r@8@.$7!":F5"E*$K=hM}$r9T$&$bNG$"$k!#*ReVolver*/C40 GO!"SS $,9b<!8w$r@8@.$7!"RCS $X9b<!8w$rAwjJV7$F;k@~$H7F=hM}9k3H$G!"%l%$%H%l!<%7%s%0$r9T$&!#3l$r<B8=$9k?aK$O!"SS $+$i RCS XN%G!<%?$NE>Aw$,I,MWG"$k!#K\9F$G=RY?SCU KOSS $+$i$N%G!<%?$r<u?.9k$?$a$NCom Port $,B8:_$7!"SS $+$i<u?.7?9b<!8w$r!"SCU $oRCS XHAw?.9k3H$,2DG=G"$k!#hC$F!"%=%U%H%&%'%"$rMQ0U9l$P%l%$%H%l!<%7%s%0$r9T$&3H$,G-$k!#

5 $*$ojK

K\9FK*$$$F!"*ReVolver*/C40 K*1kSCU $N=hM}!"@_7W!"$*hS<BAuKD$$$F=RY?!#

%[%9%H%^%7%s$O!"3F%9%F!<%8$X$N%G!<%?$NE>Aw!"3F%9%F!<%8$N@)8f!"SCU $NFbIt>uBV$N4F;k$r!"%a%b%j6u4V$K%"%/%;%9$9$k3H$G9T$&!#

SCU $O!"%[%9%H%^%7%s$H$OPCI %P%9$r2p7F!"RCS HOSCU $HRCS $NA4PE HN6&M-%a%b%jG"$kView Buffer $r2p$7$F@\B3$9$k!#PCS $*$h$SSS $NA4DSP HODSP $N;}$DCom Port $rMQ$$$F%j%s%0>u$K@\B3$5lF$$$k!#%[%9%H%^%7%s$+$iPCS $*$h$SSS XN%G!<%?$NE>Aw7PO)$O!"Com Port $N%j%s%0$HFIFO 7O$N7PO)$,B8:_$7!"L\E*$Kl~8F$=$l$>$l$r;HMQ$9$k!#

SCU $O%a%$%s%\!<%I$H%5%V%\!<%I$+iJ$k!#%a%$%s%\!<%I>eKO!"FPGA $,B8:_$7!"%[%9%H%^%7%sHN%3%M%/%?$*$h$S3F%9%F!<%8$H$N%3%M%/%?$rD>@\@\B3$9$k3H$G!"FPGA $,A4$F$r@)8f$G$-$k9=@.KJCF$$$k!#$^$?!"*ReVolver*/C40

$N3F%9%F!<%8$H$O!"E>Aw%P%C%U%!$r2p7F@\B3$7!"PCI %P%9$N%"%/%;%9$H!"RCS !"PCS $*$h$S SS XN%"%/%;%9$rJB Ns$K9T$&!#%5%V%\!<%I>eGO%/%m%C%/$N@8@.$r9T$$!"3F%9%F!<%84V$N%/%m%C%/$N0lA j$r9g$o$;$k!#

<B:]$K *ReVolver*/C40 $r;HMQ$9$k>e$G!":G$b;~4V$rMW9k%\%j%e!<%`%G!<%?$NE>Aw;~4V$O!"8.05sec $G$"$j!"1 %U%l!<%`$N2hA|@8@.$KMW9k;~4VN*h=20G\$G$"$k!#

%\%j%e!<%`%G!<%?$NE>Aw;~4V$O!"RCS $r7PM3$9$k FIFO 7O$NE>Aw7PO)$N1F6A$r<u$1$F$*$j!"SCU $+$i PCS $X$N@1MQ$N FIFO 7O$N7PO)$rMQ0U$9$k$3$H$GE>Aw;~4V$rC;=L$9$k$3$H$,$G$-$k!#$5$i$K!"%\%j%e!<%`6u4VFb$NA4%\%/%;%k$rE>Aw9kI,MW$,$J$$$H$-$K$O!"E>AwNL$KH fNc7FE>Aw;~4V$rC;=L$9k3H,G-$k!#$^$?!"%\%j%e!<%`%G!<%?$rMQ$$$?%l%$%H%l!<%7%s%0$r9T$&$?$a$K$O!"SS $+$i RCS $X$N%G!<%?$NE>Aw$,I,MW$G$"$k!#K\SCU $r7PM3$9$l$P!"$3$N%G!<%?$NE>Aw$r9T$&$3$H$,$G$-$k$N$G!"*ReVolver*/C40 $G$O!"%\%j%e!<%`%G!<%?$rMQ$$$?%l%$%H%l!<%7%s%0$r9T$&$3H,G-$k!#

<UK-

K\8&5f$N5!2q$rM?$($F$/$@5C$?!"IYEDbC<#65<x$K?<$/46<U$N0U$rI=$7$^$9!#

?t!9$NM-MQ$J8f;XF3!"8f0U8+$rD:$$$??9bC0lO:=u65<x!"8^Eg@5M5=u<j$K?4$+$i46<UCW$7$^$9!#

K\8&5f$N6&F18&5f<T$G$"$k!"F#86 2m9(;a!"5HC+ D><y;arO8a!"7W;;5!9)3X9V:B7W;;5!9=@.J,Ln$N=t;a$K46<UCW7^$9!#

;29MJ88%

[1] 5HC+ D><y, B>:*ReVolver*/C40 $N@_7W5Z$S<BAu, >pJs=hM}3X2q8&5fJs9p 97-ARC-125-5, pp25-30

[2] LZCf 01Gn:*ReVolver*/C40 $N%l%$%-%c%9%F%#%s%0%9%F!<%8$N<BAu$HI>2A, 5~ETBg3XFCJL8&5fJs9p=q(1997)

[3] Cf;3 L@B':%\%j%e!<%`%l%s%@%j%s%0@lMQJBNs7W;;5! *ReVolver*/C40 $N%T%/%;%kCM7W;;%9%F!<%8$N@_7W, =$;NO@J8, 5~ETBg3X(1996)

[4] 5HC+ D><y: *ReVolver*/C40 $N%7%'!<%G%#%s%0%9%F!<%8$N@_7W$H<BAu, 5~ETBg3XFCJL8&5fJs9p=q(1997)

[5] UtGO M:<!:%\%j%e!<%`%l%s%@%j%s%0@lMQJBNs7W;;5!——*ReVolver*/C40——,

=$;NO@J8!"5~ETBg3X(1995)

[6] PCI Special Interest Group:PCI %m!<%+%k !&P%9;EMM=qBh2.0 HG(1993)

[7] D9Eh:463,0fAR>–<BCPLD $r;H$C$?PCI %"%I%$%s%\!<%I$N:n$jJ},Interface (Oct,1997)

[8] XILINX: WORKVIEW SERIES 1 VOLUME 2

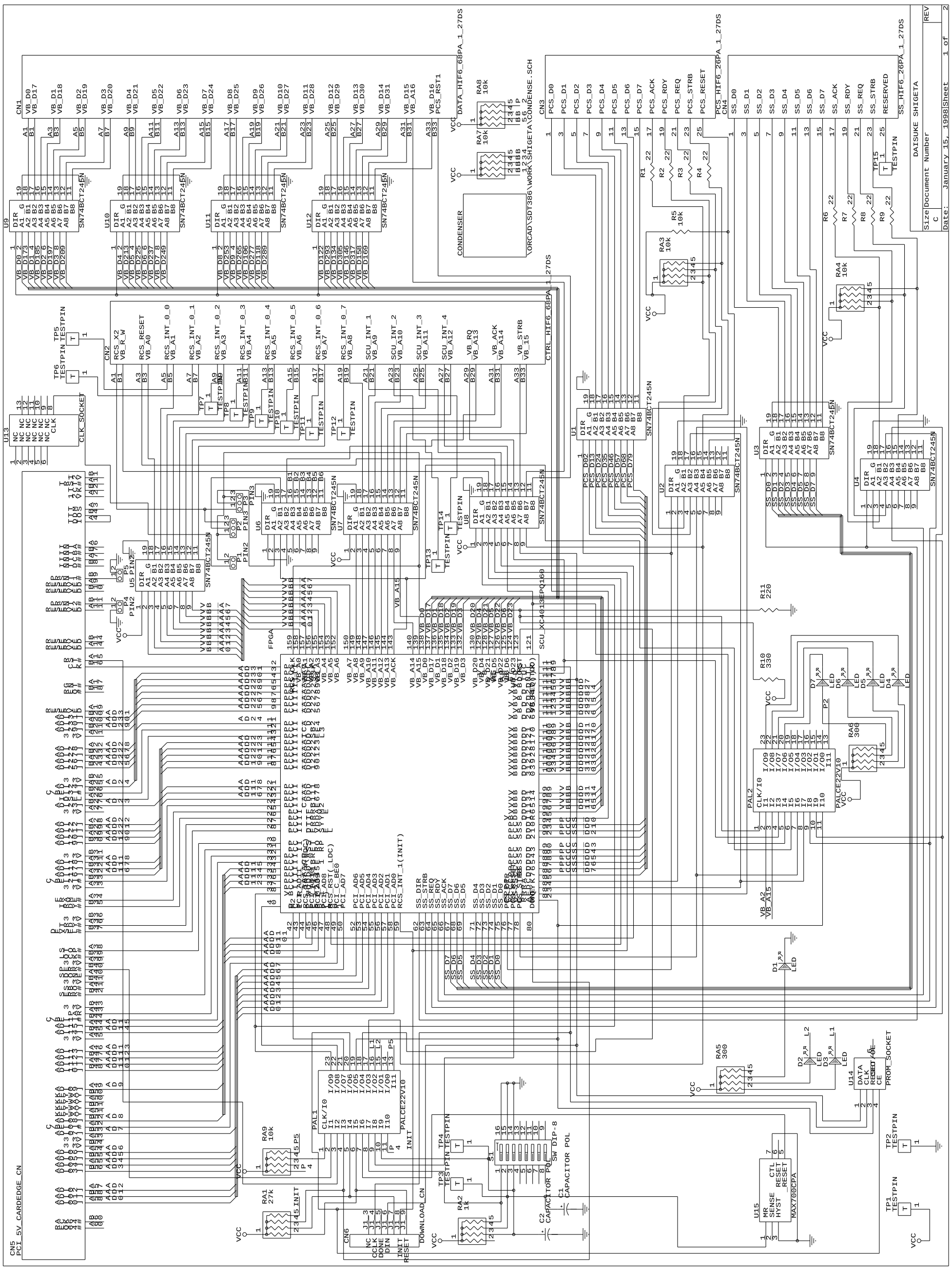
[9] XILINX: LIBRARIES GUIDE

[10] XILINX: XILINX ABEL USER GUIDE

[11] Texas Instruments:TMS320C4x User's Guide

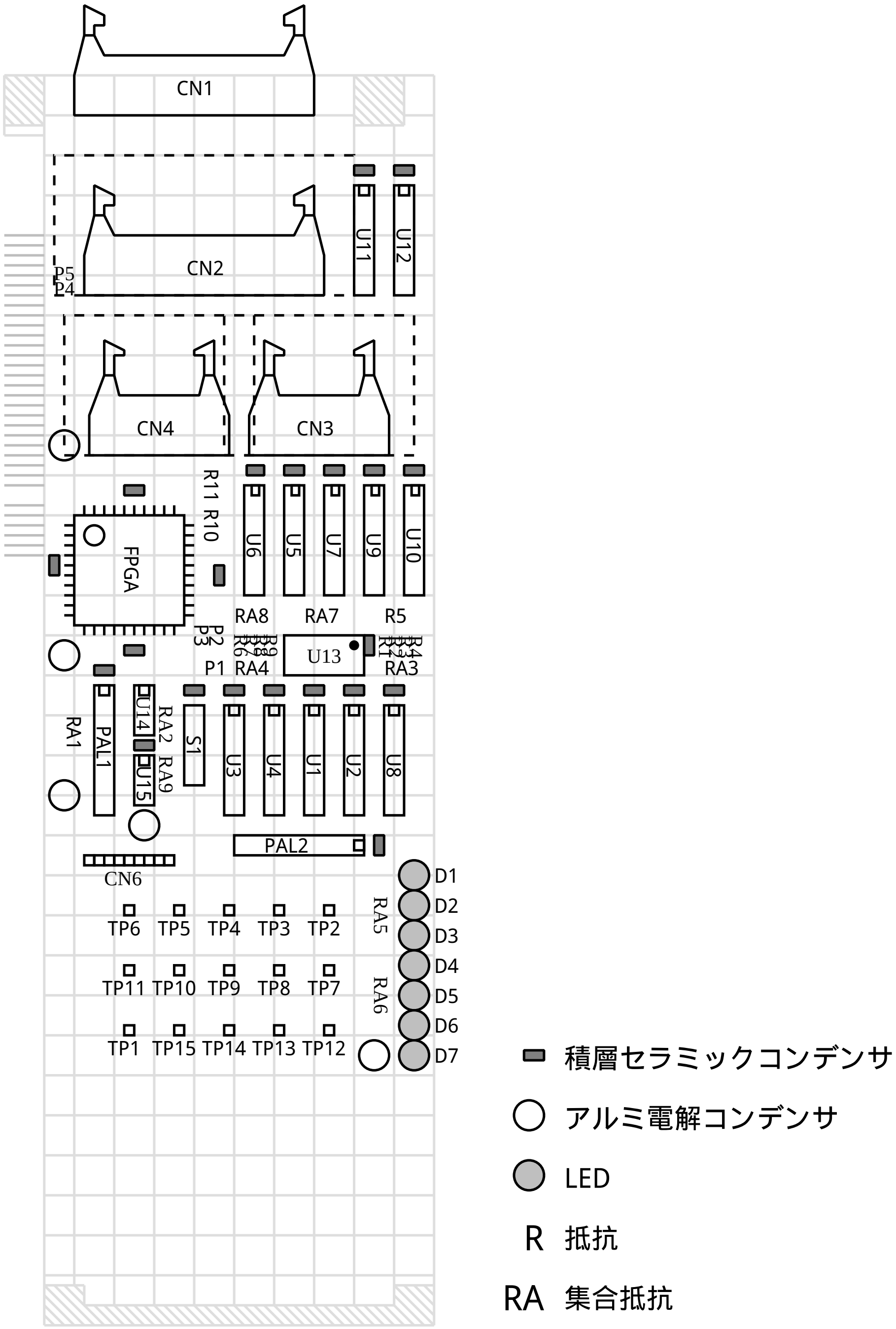
IU?

A.1 %a%$%s%\!<%IG[@~?^



?^A.1: %a%$%s%\!<%IG[@~?^

A.2 %a%$%s%\!<%I4pHDG[CV?^



?^A.2: %a%$%s%\!<%I4pHDG[CV?^