

Application Note

Rapid Switching Between Multiple Video Inputs

Matrox Meteor-II/Orion¹

Background

Matrox Meteor-II and Matrox Orion¹ include a single video decoder to capture standard video formats (i.e., NTSC/PAL or RS-170/CCIR). However, it is the multiplexer stage that enables one to connect and switch between multiple camera inputs; up to 12 CVBS or 6 Y/C inputs for Matrox Meteor-II², and up to 8 CVBS or 4 Y/C inputs for Matrox Orion. This document explains how to achieve the fastest possible switching speed with a Matrox Meteor-II or Matrox Orion when connected to multiple unsynchronized inputs of the same video format. The topics discussed in this document assumes the use of MIL/MIL-Lite 7.0, as well as a Matrox Meteor-II with rev. B (or higher) of the video decoder (see Appendix). For the remainder of this document we will use the term frame grabber to designate the Matrox Meteor-II or Matrox Orion¹.

Capture Mode

The first step to ensure fast switching is to set the grab mode to synchronous. This is done using `MdigControl(..., M_GRAB_MODE, M_SYNCHRONOUS)`^{3,4}. In synchronous mode, the grab command to capture a single frame will return control to the application once the capture operation is performed and not before. Doing so ensures that the capture operation has completed before issuing any other commands such as switching channels. Switching channels before the grab command is completed can prevent the frame grabber's circuitry from being able to determine the proper phase of the video signal (i.e., blanking versus active) quickly enough. This can produce undesired results such as additional delays due to resynchronization, display artifacts such as empty lines (black lines), or split frames (an image with fields from different channels). For more advanced users, it is possible to perform optimal channel switching in asynchronous grab mode. To do so, the application will need to manually determine precisely when the capture has been completed and implement a hook function in order to signal the switching of the input channel (perhaps by another thread). Details of how to do this are beyond the scope of this document.

The next step is to set the grab start mode to capture on the very next field (even or odd) using `MdigControl(..., M_GRAB_START_MODE, M_FIELD_START)`⁵. This prevents a variable delay during channel switch and the start of the next capture. For example, if the Grab Start Mode is set to odd (`M_FIELD_START_ODD`)⁶ and the second channel is currently on an odd field, the frame grabber will wait until the next available odd field before it starts grabbing (see Figure 1).

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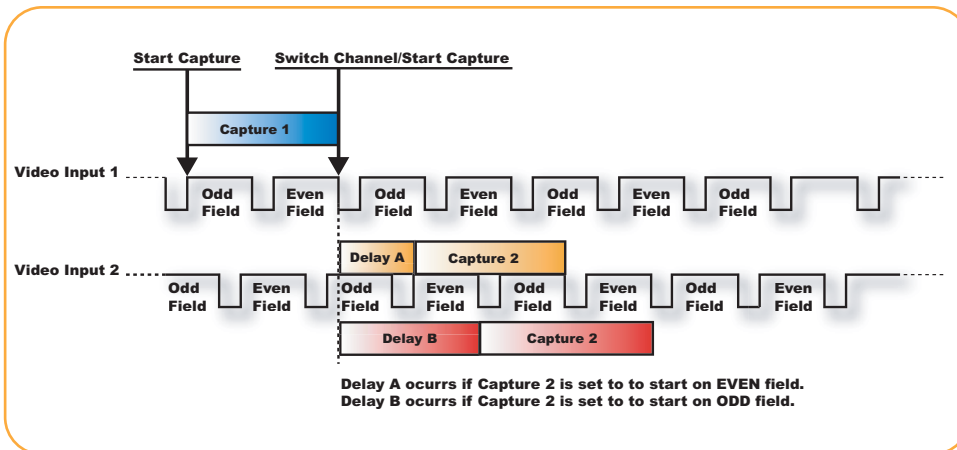


Figure 1: The smallest delay (Delay A) between a channel switch and the start of the next capture will occur when Capture 2 is set to start the very next field (M_FIELD_START). When Capture 2 is set to a specific field (such as ODD) a delay (Delay B) as long as two fields can result.

Channel Switch

Switching channels is performed using `MdigChannel(..., M_CHx)`⁷, where 'x' represents the desired channel. Refer to the MIL/MIL-Lite Board Specific Notes manual for further details related to your specific frame grabber.

Locking to the Video Source

For fastest channel switching, it is vital to ensure that the frame grabber detects the proper phase of the video signal. Using `MdigControl(..., M_CAMERA_LOCK, M_ENABLE)`⁸ ensures that following the channel switch operation the frame grabber is locked to the luminance for monochrome and color video signals, as well as to the chrominance for color video signals.

Automatic Gain Control (AGC)

Performance can also be improved by reading and saving the AGC value for each channel, disabling the AGC, and then setting the gain to a fixed level following each channel switch to the previously saved value. Start by using `MdigInquire(..., M_GRAB_INPUT_GAIN, ...)`⁹ to read and save the gain value for each channel. To disable the AGC, use `MdigControl(..., M_GRAB_AUTOMATIC_INPUT_GAIN, M_DISABLE)`¹⁰. To specify a gain value use `MdigControl(..., M_GRAB_INPUT_GAIN, x)`¹¹ where 'x' is an integer value between 0 and 255. Note however that specifying a gain value that is too low can introduce synchronization problems. Some experimentation may be required.

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Other Optimizations

Special versions of the Matrox Meteor-II digitizer configuration format (dcf) files (NTSC_FS.DCF and PAL_FS.DCF) provide further optimization by starting capture on the rising edge of the VSYNC rather than the falling edge. However, these are only available for field mode. These dcf's are on the MIL/MIL-Lite CDs (Matrox\Drivers\Meteor-II\DCF).

Measured Performance

To quantify the actual performance when switching continuously between two video cameras, Matrox Imaging used a capture and switch application that also included a timer to calculate the average combined field rate. Two cameras were connected¹² to a single Matrox Meteor-II/Matrox Orion¹ set to perform a monoshot capture. A channel switch was then performed following the capture of each field. Since the two cameras are unsynchronized and the two video signals drift from each other over time, the results measured are not absolute but rather an average over time. Furthermore the rates achieved will vary depending the board (e.g., two identical Matrox Meteor-II boards can achieve higher or lower rates) as well as camera used. The results are listed in the table below:

Matrox board	Video format	Typical field rates
Meteor-II	NTSC (Color)	» 23.3 fps
Meteor-II	PAL (Color)	» 19.9 fps
Orion for PCI/AGP	NTSC (Color)	» 16.2 fps
Orion for PCI/AGP	PAL (Color)	» 14.4 fps

The average (typical) switching time is equal to one over the typical field rate minus the field time. Thus we can deduce the actual switching time to be:

Matrox Meteor-II for NTSC	$1/23.3 \text{ fps} - 1/60 \text{ fps} = 42.9 \text{ ms} - 16.7 \text{ ms} \gg 26.2 \text{ ms}$
Matrox Meteor-II for PAL	$1/19.9 \text{ fps} - 1/50 \text{ fps} = 50.2 \text{ ms} - 20 \text{ ms} \gg 30.2 \text{ ms}$
Matrox Orion for NTSC	$1/16.2 \text{ fps} - 1/60 \text{ fps} = 61.7 \text{ ms} - 16.7 \text{ ms} \gg 45.0 \text{ ms}$
Matrox Orion for PAL	$1/14.4 \text{ fps} - 1/50 \text{ fps} = 69.4 \text{ ms} - 20 \text{ ms} \gg 49.4 \text{ ms}$

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Example Code

1. MIL Example of Fast Switching Between Video Input Channels

```
#include <stdio.h>
#include <mil.h>
#include <conio.h>

#define DCF_NAME      "ntsc_fs.dcf"

#define IMAGE_SCALE  0.5

#define NUM_CHANNELS  2

#define NB_IMAGE_X   2
#define NB_IMAGE_Y   1

void main(void)
{
    MIL_ID MilApplication,
           MilSystem,
           MilDisplay,
           MilDigitizer,
           MilImageDisp,
           MilImageDispChild[NB_IMAGE_X*NB_IMAGE_Y];

    long   Lock;
    long   ColorDigitizer = M_FALSE;
    long   Counter = 0;
    long   NbGrab = 0;
    long   X, Y;
    long   Channel [] = {M_CH0, M_CH1, M_CH2, M_CH3,
                        M_CH4, M_CH5, M_CH6, M_CH7,
                        M_CH8, M_CH9, M_CH10, M_CH11};

    long   Color[NUM_CHANNELS] = {0};
    double Wait = 0.25;
    double TimeStart, TimeEnd;
    unsigned long   AGCValue [NUM_CHANNELS];

    MappAllocDefault(M_DEFAULT, &MilApplication, &MilSystem, &MilDisplay, &MilDigitizer,
    &MilImageDisp);
    ,

```

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Example Code (cont.)

```
MbufClear(MilImageDisp, 128L);

MdispSelect(MilDisplay, MilImageDisp);

Counter = 0;
for (Y = 0; Y < NB_IMAGE_Y; Y++)
{
    for (X = 0; X < NB_IMAGE_X; X++)
    {
        MbufChild2d(MilImageDisp,
                    (long)(MdigInquire(MilDigtizer, M_SIZE_X, M_NULL) * IMAGE_SCALE * X),
                    (long)(MdigInquire(MilDigtizer, M_SIZE_Y, M_NULL) * IMAGE_SCALE * Y),
                    (long)(MdigInquire(MilDigtizer, M_SIZE_X, M_NULL) * IMAGE_SCALE),
                    (long)(MdigInquire(MilDigtizer, M_SIZE_Y, M_NULL) * IMAGE_SCALE),
                    &MilImageDispChild[Counter++]);
    }
}

if(MdigInquire(MilDigtizer, M_SIZE_BAND, M_NULL) != 1)
    ColorDigtizer = M_TRUE;

MdigControl(MilDigtizer, M_CAMERA_LOCK, M_DISABLE);
for (Counter = 0; Counter < NUM_CHANNELS; Counter++)
{
    MdigControl(MilDigtizer, M_GRAB_AUTOMATIC_INPUT_GAIN, M_ENABLE);
    MdigChannel(MilDigtizer, Channel[Counter]);
    MappTimer(M_TIMER_WAIT, &Wait);
    if( ColorDigtizer == M_TRUE)
    {
        Lock=M_FALSE;
        MdigInquire(MilDigtizer, M_CAMERA_LOCKED, &Lock);

        if(Lock == 0)
            Color[Counter]=0;
        else
            Color[Counter]=1;
    }
}
```

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Example Code (cont.)

```
Mdi gControl (Mi l Di gi ti zer, M_GRAB_AUTOMATI C_I NPUT_GAI N, M_DI SABLE);
Mdi gInqui re (Mi l Di gi ti zer, M_GRAB_I NPUT_GAI N, &AGCVal ue[Counter]);
}

Mdi gControl (Mi l Di gi ti zer, M_CAMERA_LOCK, M_ENABLE);

Mdi gControl (Mi l Di gi ti zer, M_CAMERA_LOCK_SEN SI TI VI TY, M_DEFAULT);
Mdi gControl (Mi l Di gi ti zer, M_CAMERA_UNLOCK_SEN SI TI VI TY, M_DEFAULT);

Mdi gControl (Mi l Di gi ti zer, M_GRAB_MODE, M_SYNCHRONOUS);

Mdi gControl (Mi l Di gi ti zer, M_GRAB_START_MODE, M_FI ELD_START);

Mdi gControl (Mi l Di gi ti zer, M_GRAB_SCALE, I MAGE_SCALE);

Mdi gControl (Mi l Di gi ti zer, M_GRAB_FI ELD_NUM, 1);

Mdi gControl (Mi l Di gi ti zer, M_GRAB_AUTOMATI C_I NPUT_GAI N, M_DI SABLE);

printf("Press <Enter> to stop grabbing and exit.\n\n");

Counter = NUM_CHANNELS - 1;

MappTi mer(M_TI MER_RESET, M_NULL);
MappTi mer(M_TI MER_READ, &Ti meStart);
whi le(!kbhi t())
{
    if (Counter < NUM_CHANNELS - 1)
        Counter++;
    el se
        Counter = 0;

    Mdi gControl (Mi l Di gi ti zer, M_GRAB_I NPUT_GAI N, AGCVal ue[Counter]);

    if (Col or[Counter])
        Mdi gControl (Mi l Di gi ti zer, M_CAMERA_COLOR_LOCK, M_ENABLE);
    el se
        Mdi gControl (Mi l Di gi ti zer, M_CAMERA_COLOR_LOCK, M_DI SABLE);
```

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Example Code (cont.)

```
Mdi gChannel (Mi l Di gi ti zer, Channel [Counter]);
Mdi gGrab(Mi l Di gi ti zer, Mi l ImageDi spChi l d[Counter]);

NbGrab++;
if((NbGrab % 100) == 0)
{
    MappTi mer(M_TI MER_READ, &Ti meEnd);
    printf("%d fields grabbed at %f fps\r", NbGrab, 100/(Ti meEnd- Ti meStart));
    MappTi mer(M_TI MER_READ, &Ti meStart);
}

MappTi mer(M_TI MER_READ, &Ti meEnd);

printf("\n\n%d Total fields grabbed at an average of %f fps\n", NbGrab, NbGrab/Ti meEnd);
printf("Press <Enter> to end.\n");
getchar();

for (Counter = 0; Counter < NB_I MAGE_X*NB_I MAGE_Y; Counter++)
{
    MbufFree(Mi l ImageDi spChi l d[Counter]);
}

MbufFree(Mi l ImageDi sp);
Mdi gFree(Mi l Di gi ti zer);
Mdi spFree(Mi l Di spl ay);
MsysFree(Mi l System);
MappFree(Mi l Appl i cati on);
}
```

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Example Code (cont.)

2. ActiveMIL Example of Channel Switching

Option Explicit

```
Const IMAGE_SCALE = 0.5
```

```
Const NUMBER_CHANNELS = 2 ' Maximum 12
```

```
Public IsGrabbing As Boolean  
Dim CameraIsColor() As Boolean  
Dim AutomaticInputGainValue() As Long  
Dim Channel(0 To 11) As Long  
Dim ChildImages(0 To NUMBER_CHANNELS - 1) As MIL.Image  
Dim NbGrab As Long  
Dim TimeEnd As Double  
Dim m_StopGrabLoop As Boolean  
Dim m_KillLoop As Boolean
```

```
Private Sub Form_Load()
```

```
Channel(0) = digCh0: Channel(1) = digCh1: Channel(2) = digCh2: Channel(3) = digCh3  
Channel(4) = digCh4: Channel(5) = digCh5: Channel(6) = digCh6: Channel(7) = digCh7  
Channel(8) = digCh8: Channel(9) = digCh9: Channel(10) = digCh10: Channel(11) = digCh11
```

```
ReDim CameraIsColor(0 To NUMBER_CHANNELS - 1)  
ReDim AutomaticInputGainValue(0 To NUMBER_CHANNELS - 1)
```

```
Digitizer.ScaleX = IMAGE_SCALE  
Digitizer.ScaleY = IMAGE_SCALE
```

```
If ImageBuffer.IsAllocated Then ImageBuffer.Free  
ImageBuffer.NumberOfBands = Digitizer.NumberOfBands  
ImageBuffer.SizeX = Digitizer.SizeX * IMAGE_SCALE * NUMBER_IMAGE_X  
ImageBuffer.SizeY = Digitizer.SizeY * IMAGE_SCALE * NUMBER_IMAGE_Y  
ImageBuffer.Allocate
```

```
ImageBuffer.Clear 128
```

```
Dim CurrentChannel As Long  
Dim y As Long  
Dim x As Long
```

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Example Code (cont.)

```
For y = 0 To NUMBER_IMAGE_Y - 1
  For x = 0 To NUMBER_IMAGE_X - 1

    Dim NewChildImage As MIL.Image
    Set NewChildImage = Application.CreateObject("MIL.Image", False)

    With NewChildImage
      .ParentImage = ImageBuffer
      .ChildRegion.OffsetX = Digitizer.SizeX * IMAGE_SCALE * x
      .ChildRegion.OffsetY = Digitizer.SizeY * IMAGE_SCALE * y
      .ChildRegion.SizeX = Digitizer.SizeX * IMAGE_SCALE
      .ChildRegion.SizeY = Digitizer.SizeY * IMAGE_SCALE
      .Allocate

      Set ChildImages(CurrentChannel) = NewChildImage
      CurrentChannel = CurrentChannel + 1
    End With
  Next
Next

AdjustForm Me

Dim ColorDigitizer As Boolean
If Digitizer.NumberOfBands <> 1 Then
  ColorDigitizer = True
End If

Digitizer.CameraLockEnabled = False

For CurrentChannel = 0 To NUMBER_CHANNELS - 1

  Digitizer.AutomaticInputGain = True
  Digitizer.Channel = Channel(CurrentChannel)
  Application.Timer.Wait 0.25

  If ColorDigitizer = True Then
    CameraIsColor(CurrentChannel) = Digitizer.IsCameraLocked
  End If

  Digitizer.AutomaticInputGain = False
  AutomaticInputGainValue(CurrentChannel) = Digitizer.InputGain
Next
```

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Example Code (cont.)

```
Digitizer.CameraLockEnabled = True
Digitizer.CameraLockSensitivity = digDefault
Digitizer.CameraUnlockSensitivity = digDefault
Digitizer.GrabMode = digSynchronous
Digitizer.GrabStartMode = digFieldStart
Digitizer.GrabFieldNumber = 1
Digitizer.AutomaticInputGain = False
m_StopGrabLoop = False
m_KillLoop = False
lblComment = "Click Next to start the grab on two channels. "
End Sub
Private Sub cmdNext_Click()
    AdjustStepNumber Me
    Select Case cmdNext.Tag
        Case 2
            lblComment = "Grab image on all channels. Switch from one " & _
                "channel to other. Click Next to stop grabbing. "
            GrabLoop
        Case 3
            m_StopGrabLoop = True
            TimeEnd = Application.Timer.Read
            lblComment = NbGrab & " Total fields grabbed at an average of " & _
                Format(NbGrab / TimeEnd, "###0.00") & "fps" & _
                ". Click Next to End."
            DoEvents
        Case Else
            Unload Me
    End Select
End Sub
```

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Example Code (cont.)

```
Private Sub GrabLoop()  
    Dim TimeStart As Double  
    Dim CurrentChannel As Long  
  
    CurrentChannel = NUMBER_CHANNELS - 1  
  
    Application.Timer.Reset  
    TimeStart = Application.Timer.Read  
  
    While (Not m_StopGrabLoop And Not m_KillLoop)  
        If CurrentChannel < NUMBER_CHANNELS - 1 Then  
            CurrentChannel = CurrentChannel + 1  
        Else  
            CurrentChannel = 0  
        End If  
  
        Digitizer.InputGain = Automati cInputGai nVal ue(Current Channel )  
  
        If CameraIsCol or(CurrentChannel) Then  
            Digitizer.CameraCol orLockEnabl ed = True  
        Else  
            Digitizer.CameraCol orLockEnabl ed = Fal se  
        End If  
  
        Digitizer.Channel = Channel (CurrentChannel)  
        Digitizer.Image = ChildI mages(CurrentChannel)  
  
        Digitizer.Grab  
        NbGrab = NbGrab + 1  
  
        If (NbGrab Mod 100) = 0 Then  
            TimeEnd = Application.Timer.Read  
            lblComment = NbGrab & " fields grabbed at " &  
                Format(100 / (TimeEnd - TimeStart), "###0.00") _  
                & "fps. Click next to stop grabbing."  
            TimeStart = Application.Timer.Read  
        End If  
  
        DoEvents  
  
    Wend  
End Sub  
  
Private Sub Form_Unload(Cancel As Integer)  
    m_KillLoop = True  
End Sub
```

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Appendix

To determine which revision of the video decoder is on your Matrox Meteor-II board, simply locate the component on the board as illustrated in Figure 2. A revision 'A' decoder is identified with 'KS0127' as shown. If the decoder is labeled with any other identification, it is a revision 'B'. Note that Matrox Orion boards are only equipped with revision 'B' and higher decoder chips.

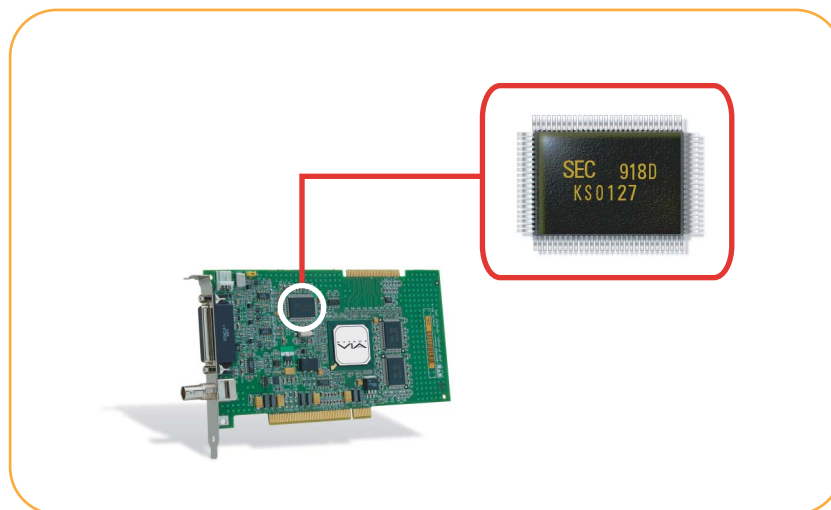


Figure 2: Location of video decoder on Matrox Meteor-II. Revision 'A' of the decoder chip (right) can be easily identified by the 'KS0127' stamp on the chip

Endnotes:

1. Includes Matrox Orion module for 4Sight-II
2. Up to 7 CVBS or 3 Y/C inputs on CompactPCI[®] version.
3. Digitizer.GrabMode = digSynchronous; property for ActiveMIL/ActiveMIL-Lite.
4. Synchronous grab mode is the default setting for MIL and ActiveMIL.
5. Digitizer.GrabStartMode = digFieldStart; property for ActiveMIL/ActiveMIL-Lite.
6. Digitizer.GrabStartMode = digFieldStartOdd; property for ActiveMIL/ActiveMIL-Lite.
7. Digitizer.Channel = digChx, where the x represents the desired channel; property for ActiveMIL/ActiveMIL-Lite.
8. Digitizer.CameraLockEnabled = True; property for ActiveMIL/ActiveMIL-Lite.
9. x = Digitizer.InputGain, where the x represents the desired channel; property for ActiveMIL/ActiveMIL-Lite.
10. Digitizer.AutomaticInputGain = False; property for ActiveMIL/ActiveMIL-Lite.
11. Digitizer.InputGain = x, where the x is a integer value between 0 and 255; property for ActiveMIL/ActiveMIL-Lite.
12. In a Dell Dimension 4100 (PIII @ 1 GHz) with a Matrox G400 AGP.