

HYBRID SEQUENCER VERSION 2.0

Overview

The Hybrid Sequencer is a program designed to communicate with the FlexTek FCIF010 FlexBus Board via a RS232 serial port from a PC. The FlexBus in turn controls a custom interface board containing MOSFET power switches that activate the igniter and solenoids of the hybrid motor static test stand.



The FC1F010 is a multi-function micro controller with a modest amount of Digital I/O and Analog to Digital converters

<http://www.flex-tek.com/index.html>

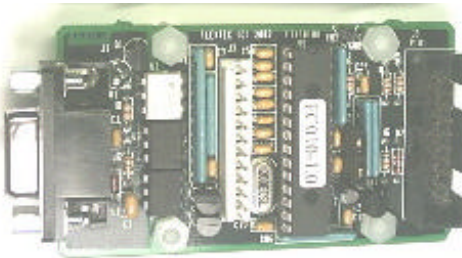


Figure 1 FCIF010.....FlexBus™ Interface Board

The FlexBus board has 5 A/D channels, 4 digital outputs, 4 digital inputs, 1 Pulse Width modulated output and 1 timer. Currently Hybrid Sequencer 2.0 only utilizes 4 digital outputs.

The FlexBus micro controller is designed to be easily programmed with Visual Basic and utilizes an ActiveX component named EZX.ocx (“FTView” for newer versions) which handles the interface between the Visual Basic program and the micro controller hardware. This ActiveX control can be downloaded from the FlexTek website and can be inserted as a Control Component in your Visual Basic project.

The screenshot shows the EZX 1.0 ActiveX control interface. It features a title bar 'EZX 1.0'. The main area contains several input fields and checkboxes. At the top, there are dropdown menus for 'Comm1' and 'Addr0', and buttons for 'Connect' and 'Ready'. Below these are input fields for 'Fw: 1.0', 'ID: Flextek', 'Vref: 5.0000', and a series of 'AD' (AD0 to AD4) and 'DIT', 'DIF', 'CLK' fields. There are also percentage fields for 'PWM', 'DPW', and 'DOG'. At the bottom, there are checkboxes for 'DON', 'DOE', 'DOK', 'DOS', 'DIF', 'DIT', 'DIN', 'DIS', and 'RST'. Below the checkboxes are buttons for 'Update', 'Clear', and 'Zero', and the website 'www.flex-tek.com'.

Figure 2 EZX 1.0 ActiveX control

The Hybrid Sequencer 2.0 program is designed to command this ActiveX control in a particular timed sequence that is determined by the user through a graphical interface.

Installation

To install Hybrid Sequencer 2.0:

- 1) Download appropriate installation file. (Win98, 2000 or XP)
- 2) Click on Hybrid Sequencer Setup file.
- 3) Select Destination location from installed files.
- 4) After installation, start program by clicking on desktop icon or go to START > PROGRAMS.

Operation

Upon starting the Hybrid Sequencer 2.0 executable file the 'FlexControl' form is loaded. This custom interface is what handles the automated control of the EZX 1.0 ActiveX object.

The Hybrid Sequencer program has two primary functions:

- 1) Automated control the digital output channels of the FlexBus and Interface board to activate and deactivate them at the appropriate times thus turning on and off the solenoids for the oxidizer, purge and igniter functions.
- 2) Serve as a manual interface with the FlexBus and Interface board by selecting the digital output channels as required through the 'Test Panel' buttons.



Interface

- 1) **Connect:** In order for the program to communicate with the FlexBus Interface board the "Connect" button must be pushed. This button sets `EZX1.CommPort = 1` which establishes serial communication with the FlexBus board on Comm Port 1.
- 2) **Countdown:** The number of seconds that will be counted down before the igniter is started. Countdown must have a minimum value of 1 second.

- 3) **Ignition:** The time at which the igniter becomes active by setting `EZX1.DOKstate = 1` the value is fixed at T minus 0 and cannot be changed. This is the time point on which the rest of the firing sequence is referenced.
- 4) **Oxidizer ON:** The time at which the solenoid controlling the pressurized nitrogen, to the OPEN side of the oxidizer pneumatic ball valve, is activated by setting `EZX1.DOSstate = 1` at this point the igniter is de asserted by setting `EZX1.DOKstate = 0`. Oxidizer ON must be at least one second later than Ignition.
- 5) **Oxidizer OFF:** The time at which the solenoid controlling the pressurized nitrogen, to the CLOSE side of the oxidizer pneumatic ball valve, is activated by setting `EZX1.DOEstate = 1`. Also at this point the solenoid controlling the OPEN side is deactivated by setting `EZX1.DOSstate = 0`. If no purge is used then the CLOSE solenoid will be deactivated by setting `EZX1.DOEstate = 0` two seconds after Oxidizer OFF. Oxidizer OFF must occur at least 1 second after Oxidizer ON.
- 6) **Purge ON:** If a purge is used then this is the time at which the inert gas purge solenoid is activated by setting the `EZX1.DONstate = 1`. Also at this point the solenoid controlling the CLOSE side of the oxidizer pneumatic ball valve is de activated by setting `EZX1.DOEstate = 0`. Purge ON must occur at least 1 second after Oxidizer OFF.
- 7) **Purge OFF:** If a purge is used then this is the time at which the inert gas purge solenoid is deactivated by setting the `EZX1.DONstate = 1`. Purge OFF must occur at least 1 second after Purge ON.
- 8) **Status:** This is the general message field that displays status messages as well as error messages.
- 9) **START:** This button will be enabled once the connect button is pressed. Once the Start button is pressed a logic check is performed on the sequence time fields to make sure they are entered correctly. If the sequence logic is valid then the countdown will proceed.
- 10) **ABORT:** Terminates the sequence and deactivates `DOK`, `DOS`, `DOE` and `DON`.

Test Panel

- 11) **Igniter:** Manually toggles `DOK` activate/deactivate when clicked.
- 12) **Oxidizer ON:** Manually toggles `DOS` activate/deactivate when clicked.
- 13) **Oxidizer OFF:** Manually toggles `DOE` activate/deactivate when clicked.
- 14) **Purge:** Manually toggles `DON` activate/deactivate when clicked.

NOTE

?? If the Hybrid Sequencer 2.0 'FlexControl' form is maximized on the screen, the 'show flextek interface' button will become visible. Clicking this button will allow the user to view the activity and status of the control signals being sent to the micro controller from the executable via this ActiveX control.

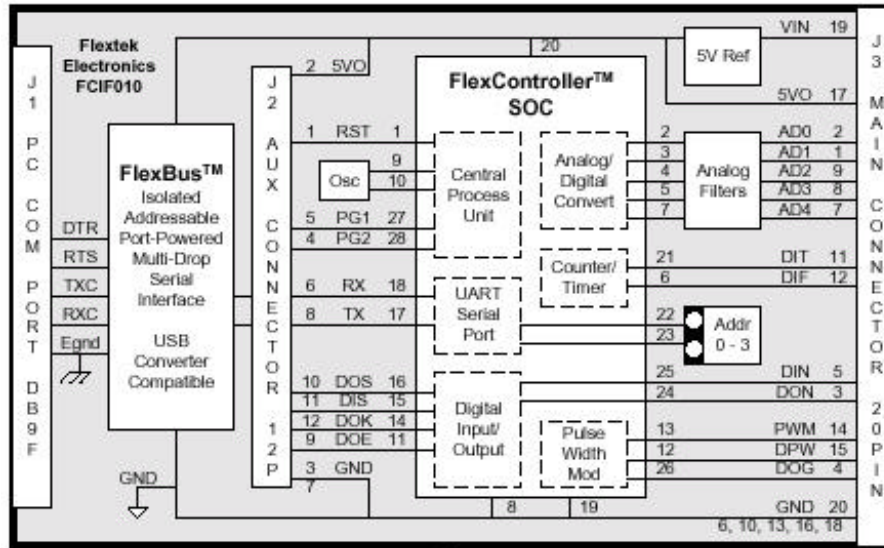


Figure 4 FlexBus™ Board Block Diagram

Visual Basic 6.0 Source Code for Hybrid Sequencer Version 2.0

```

Dim COUNTDOWN As Integer
Dim COUNTUP As Integer
Dim OXIDIZERON As Integer
Dim OXIDIZEROFF As Integer
Dim PURGEON As Integer
Dim PURGEOFF As Integer
Dim ERROR As Integer
Dim PURGE As Boolean
Dim SequenceCheck As Boolean
Dim COUNTDOWNACTIVE As Boolean

Private Sub cmdabort_Click()
    EZX1.DOKstate = 0
    EZX1.DOEstate = 0
    EZX1.DONstate = 0
    EZX1.DOSstate = 0
    txtcount.Text = txtcountdown.Text
    lbltsign.Text = "T minus"
    tmrhybrid1.Enabled = False
    txtstatus.Text = "Sequence Aborted"
    EZX1.UpdateCmd = True
End Sub

Private Sub cmdconnect_Click()
    If EZX1.CommPort = 0 Then
        EZX1.CommPort = 1
        txtstatus.Text = "Connected"
        EZX1.UpdateCmd = True
        cmdstart.Enabled = True
    ElseIf EZX1.CommPort = 1 Then
        EZX1.CommPort = 0
        txtstatus.Text = "Disconnected"
        cmdstart.Enabled = True
    End If

```

```

        End If
    End Sub

    Private Sub cmdigniter_Click()
        If EZX1.DOKstate = 0 Then
            EZX1.DOKstate = 1
            txtstatus.Text = "DOK Active"
        ElseIf EZX1.DOKstate = 1 Then
            EZX1.DOKstate = 0
            txtstatus.Text = "DOK Inactive"
        End If
        EZX1.UpdateCmd = True
    End Sub

    Private Sub cmdoxidizeroff_Click()
        If EZX1.DOEstimate = 0 Then
            EZX1.DOEstimate = 1
            txtstatus.Text = "DOE Active"
        ElseIf EZX1.DOEstimate = 1 Then
            EZX1.DOEstimate = 0
            txtstatus.Text = "DOE Inactive"
        End If
        EZX1.UpdateCmd = True
    End Sub

    Private Sub cmdoxidizeron_Click()
        If EZX1.DOSstate = 0 Then
            EZX1.DOSstate = 1
            txtstatus.Text = "DOS Active"
        ElseIf EZX1.DOSstate = 1 Then
            EZX1.DOSstate = 0
            txtstatus.Text = "DOS Inactive"
        End If
        EZX1.UpdateCmd = True
    End Sub

    Private Sub cmdpurge_Click()
        If EZX1.DONstate = 0 Then
            EZX1.DONstate = 1
            txtstatus.Text = "DON Active"
        ElseIf EZX1.DONstate = 1 Then
            EZX1.DONstate = 0
            txtstatus.Text = "DON Inactive"
        End If
        EZX1.UpdateCmd = True
    End Sub

    Private Sub cmdstart_Click()
        COUNTDOWN = Val(txtcountdown.Text)
        COUNTUP = Val(txtignition.Text)
        COUNTDOWNACTIVE = True
        OXIDIZERON = Val(txtoxidizeron.Text)
        OXIDIZEROFF = Val(txtoxidizeroff.Text)
        PURGEON = Val(txtpurgeon.Text)
        PURGEOFF = Val(txtpurgeoff.Text)
        Call SequenceLogicCheck
        If SequenceCheck = True Then
            tmrhybrid1.Enabled = True
        End If
    End Sub

    Private Sub SequenceLogicCheck()
        If COUNTDOWN > 0 Then
            If OXIDIZERON > 0 Then
                If OXIDIZEROFF > OXIDIZERON Then
                    If PURGEON > OXIDIZEROFF Then
                        If PURGEOFF > PURGEON Then
                            PURGE = True
                            SequenceCheck = True
                        Else
                            PURGE = False
                            SequenceCheck = True
                        End If
                    End If
                End If
            End If
        End If
    End Sub

```

```

        txtpurgeon.Text = "---"
        txtpurgeoff.Text = "---"
    End If
Else
    PURGE = False
    SequenceCheck = True
    txtpurgeon.Text = "---"
    txtpurgeoff.Text = "---"
End If
Else
    txtstatus.Text = "Oxidizer Off must be > Oxidizer On"
    SequenceCheck = False
End If
Else
    txtstatus.Text = "Oxidizer On must occur at T+1 second or later"
    SequenceCheck = False
End If
Else
    txtstatus.Text = "Countdown must be >= 1 second"
    SequenceCheck = False
End If
End Sub

Private Sub Command1_Click()
If EZX1.Visible = False Then
    EZX1.Visible = True
ElseIf EZX1.Visible = True Then
    EZX1.Visible = False
End If
End Sub

Private Sub Form_Load()
    tmrhybrid1.Enabled = False
    tmrhybrid2.Enabled = False
    cmdstart.Enabled = False
    txtcount.Text = txtcountdown.Text
    frmFlexControl.Show
End Sub

Private Sub tmrhybrid1_Timer()
    If COUNTDOWNACTIVE = True Then
        COUNTDOWN = COUNTDOWN - 1
        txtcount.Text = COUNTDOWN
        lbltsign.Text = "T minus"
        txtpurgeoff.BackColor = &H80000005 'white
        txtoxidizeroff.BackColor = &H80000005 'white
        txtcountdown.BackColor = &HFF& 'red
        Beep
        If COUNTDOWN <= 1 Then
            COUNTDOWNACTIVE = False
        End If
    ElseIf COUNTDOWNACTIVE = False Then
        lbltsign.Text = "T plus"
        txtcount.Text = COUNTUP
        If COUNTUP < OXIDIZERON Then
            EZX1.DOKstate = 1 'Igniter active
            txtcountdown.BackColor = &H80000005 'white
            txtignition.BackColor = &HFF& 'red
            txtignition.ForeColor = &H80000005
            txtstatus.Text = "Ignition"
        ElseIf COUNTUP >= OXIDIZERON And COUNTUP < OXIDIZEROFF Then
            EZX1.DOKstate = 0
            txtignition.BackColor = &H80000005 'white
            txtignition.ForeColor = &HFF& 'black
            EZX1.DOSstate = 1 'Oxidizer ON active
            txtoxidizeron.BackColor = &HFF& 'red
            txtstatus.Text = "Oxidizer ON"
        ElseIf COUNTUP >= OXIDIZEROFF And COUNTUP < PURGEON And PURGE = True Then
            EZX1.DOSstate = 0
            txtoxidizeron.BackColor = &H80000005 'white
            txtoxidizeroff.BackColor = &HFF& 'red
        End If
    End If
End Sub

```



```

        EZX1.DOEstate = 1                                'Oxidizer OFF is active
        txtstatus.Text = "Oxidizer OFF "
    ElseIf COUNTUP >= PURGEON And COUNTUP < PURGEOFF And PURGE = True Then
        EZX1.DOEstate = 0
        EZX1.DONstate = 1                                'Purge Active
        txtoxidizeroff.BackColor = &H80000005            'white
        txtpurgeon.BackColor = &HFF&                      'red
        txtstatus.Text = "Purge ON"
    ElseIf COUNTUP >= PURGEOFF And PURGE = True Then
        EZX1.DOSstate = 0
        txtpurgeon.BackColor = &H80000005                'white
        txtpurgeoff.BackColor = &HFF&                      'red
        txtstatus.Text = " Purge OFF"
        tmrhybrid1.Enabled = False
    Else
        EZX1.DOSstate = 0
        EZX1.DOEstate = 1
        txtoxidizeron.BackColor = &H80000005              'white
        txtoxidizeroff.BackColor = &HFF&                  'red
        txtstatus.Text = "Oxidizer OFF"
        tmrhybrid1.Enabled = False
        tmrhybrid2.Enabled = True
    End If
    EZX1.UpdateCmd = True
    COUNTUP = COUNTUP + 1
    Beep
End If

End Sub

Private Sub tmrhybrid2_Timer()
    txtoxidizeroff.BackColor = &H80000005                'white
    EZX1.DOEstate = 0
    EZX1.UpdateCmd = True
    tmrhybrid2.Enabled = False
End Sub

Private Sub txtcountdown_Change()
    txtcount.Text = txtcountdown.Text
End Sub

Private Sub txtpurgeoff_Change()
    If txtpurgeoff.Text = "0" Then
        txtpurgeoff.Text = "---"
    End If
End Sub

Private Sub txtpurgeon_Change()
    If txtpurgeon.Text = "0" Then
        txtpurgeon.Text = "---"
    End If
End Sub

```