Efficient Triggering on LXI-based ATE System

Kit Ling, VTI Instruments
ATE System Industries

- Manufacturing
- Avionics
- Aerospace
- Military
- Defense
LXI-based ATE System
Connection

Host Controller

ENET Switch

6.5 Digit DMM

48 ch. Mux

48 Analog Signals
ATE System
Triggering Between Multiple Devices

Triggering Methods
- Digital I/O
- Backplane
- External Hardware Trigger
- **LAN Event**
- **LXI Trigger Bus**
- **Software Triggering**
Triggering Methods
Software Triggering

VTEDmm IVI Driver Reference

VTEDmm_SendSoftwareTrigger Function

Low Level Measurement  See Also

Sends a software trigger, which causes the DMM to take a measurement.

Function Tree Node: \VTEDmm\Measurement\Low Level Measurement\Send Software Trigger
Declaration: VTEDmm.h
Implementation: VTEDmm.dll

Syntax

Visual C++

ViStatus VTEDmm_SendSoftwareTrigger(
    ViSession Vi
);

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## Triggering Methods

### Software Triggering

<table>
<thead>
<tr>
<th>Step</th>
<th>Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Send Command Close ChN</td>
<td>Variable</td>
</tr>
<tr>
<td>Wait for Switch Settle</td>
<td>5</td>
</tr>
<tr>
<td>Send DMM Measure Command</td>
<td>Variable</td>
</tr>
<tr>
<td>Poll on DMM Measure Complete (or wait)</td>
<td>1.67</td>
</tr>
<tr>
<td>Send Command Open ChN</td>
<td>Variable</td>
</tr>
</tbody>
</table>

Removing all variables, best case scenario:

$$\frac{1}{(1.67 \text{ ms} + 5 \text{ ms})} \times 384 = 2.56 \text{ seconds}$$

**150 readings/second**

**Actual Measured:** 63 rdgs/s

*Protocol overhead carried for every switch measure loop*
Triggering Methods
LAN Events

LAN Events - No PC Intervention
Triggering Methods
LAN Events

Actual Measured: 92 rdgs/s

Processing LAN events/implementation impacting efficiency
Triggering Methods
LAN Events

// Dmm trigger setup
Dmm.Trigger.Source = VTEXDmm.Trigger.SourceEnum.VTEXDmm.Trigger.SourceBPL1;

// Switch trigger setup
sw.Scan.ConfigureTrigger(0,
VTEXSwitchTriggerInputEnum.VTEXSwitchTriggerInputBPL2,
VTEXSwitchAdvancedOutputEnum.VTEXSwitchAdvancedOutputBPL3);

// Route the signal from BPL0 to LAN2
DmmSystem.InstrumentSpecific.Route.Destinations.Item["LAN2"].SourcesList = "BPL0";

// Route the signal from LAN1 to BPL1
DmmSystem.InstrumentSpecific.Route.Destinations.Item["BPL1"].SourcesList = "LAN1";

// Route the signal from BPL3 to LAN1
DmmSystem.InstrumentSpecific.Route.Destinations.Item["LAN1"].SourcesList = "BPL3";

// Initiate switch and Dmm
Dmm.Measurement.Initiate();
sw.Scan.Initiate();

// Fetch all the data from the FIFO in 1000ms
Dmm.Measurement.FetchMultiPointTimeStamped(1000, ref reading, ref second, ref fraction);
Triggering Methods
LXI Trigger Bus

WTB Termination
Triggering Methods
LXI Trigger Bus

Actual Measured: 145 rdgs/s

Again, there is minimal impact due to protocol overhead
// Setup LXI domain of each EXI200 system
const LXIDomain = 0;
switch (LXIDomain) {
    case 0:
        // Triggering setup
            VXEXDmmMeasurementCompleteDestBPL0;
        dmm.System.Trigger.Source = VXEXDmmTriggerSourceEnum.VXEXDmmTriggerSourceBPL1;
        break;
    
    case 1:
        // Switch trigger setup
        switch (LXIDomain) {
            case 0:
                // Route the signal from BPL0 to LAN2
                dmm.System.InstrumentSpecific.Route.Destinations.Item("BPL0").SourcesList = "LXI2";
                    VXEXSystemEventDriveModeEnum.VXEXSystemEventDriveModeDriven;
                break;
            
            case 1:
                // Route the signal from LAN1 to BPL1
                dmm.System.InstrumentSpecific.Route.Destinations.Item("BPL1").SourcesList = "LXI1";
                    VXEXSystemEventDriveModeEnum.VXEXSystemEventDriveModeDriven;
                break;
        }
        break;
    
    case 2:
        // Route the signal from BPL3 to LAN1
        dmm.System.InstrumentSpecific.Route.Destinations.Item("BPL3").SourcesList = "BPL1";
            VXEXSystemEventDriveModeEnum.VXEXSystemEventDriveModeDriven;
        break;
}

// Fetch all the data from the FIFO in 1000ms
const ref reading = VEXSystemMeasurementFetcherEventTimeStamped(1000, ref reading, ref second, ref fraction);
### Trigger Methods
#### Results Comparison

<table>
<thead>
<tr>
<th>Method (Electromechanical, 5 ms settle)</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Triggering</td>
<td>63 rdgs/sec</td>
</tr>
<tr>
<td>LAN Event</td>
<td>92 rdgs/sec</td>
</tr>
<tr>
<td>LXI Trigger Bus</td>
<td>145 rdgs/sec</td>
</tr>
<tr>
<td>Theoretical Max</td>
<td>150 rdgs/sec</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Determinism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Triggering</td>
</tr>
<tr>
<td>LAN Event</td>
</tr>
<tr>
<td>LXI Trigger Bus</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method (Solid-State, 0.2 ms ON time)</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Triggering</td>
<td>60 rdgs/sec</td>
</tr>
<tr>
<td>LAN Event</td>
<td>123 rdgs/sec</td>
</tr>
<tr>
<td>LXI Trigger Bus</td>
<td>522 rdgs/sec</td>
</tr>
<tr>
<td>Theoretical Max</td>
<td>535 rdgs/sec</td>
</tr>
</tbody>
</table>

- **Resolution of WAIT statement**

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Summary

• Software Triggering
  • Intuitive and straight-forward to implement
  • Significantly affected by program overhead

• LAN Event
  • More complicated to implement
  • Provides millisecond level of triggering
  • Easy distribution without distance limitation
  • Does not require external cables

• LXI Trigger Bus
  • More complicated to implement
  • Provides nanosecond level of triggering
  • Cannot be distributed
  • Requires external cables
Thank you !