M2i.72xx - 32 bit pattern generator with programmable levels

- Programmable output levels from -2.0 V up to +10.0 V
- Levels individually programmable per 4 bit
- Up to 40 MS/s at 32 bit
- All Outputs can be separately disabled (Tristate)
- Hardware controlled differential output possible
- Up to 2 GByte on-board memory
- 512 MByte standard memory installed
- FIFO mode for output
- Sustained streaming mode
- Edge/pulse width/delay trigger
- Synchronization of up to 16 cards per system and up to 271 cards with system sync
- Features: Multiple Replay, Gated Replay, BaseXI0

- 66 MHz 32 bit PCI-X interface
- 5V / 3.3V PCI compatible
- 100% compatible to conventional PCI > V2.1
- Sustained streaming mode up to 245 MB/s

- 2.5 GBit x1 PCIe Interface
- Works with x1/x4/x8/x16* PCIe slots
- Software compatible to PCI
- Sustained streaming mode up to 160 MB/s

Operating Systems
- Windows 7 (SP1), 8, 10
- Linux Kernel 2.4, 2.6, 3.x, 4.x
- Windows/Linux 32 and 64 bit

Recommended Software
- SBench 6
- MATLAB
- LabVIEW, LabWindows/CVI

Drivers and Examples
- C/C++, GNU C++
- Delphi, VB.NET, C#, J#
- Python, Java

<table>
<thead>
<tr>
<th>Model</th>
<th>1-4 bit</th>
<th>8 bit</th>
<th>16 bit</th>
<th>32 bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2i.7210</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
</tr>
<tr>
<td>M2i.7211</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>5 MS/s</td>
</tr>
<tr>
<td>M2i.7220</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
</tr>
<tr>
<td>M2i.7221</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
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</tbody>
</table>

General Information
The M2i.72xx pattern generator series gives the user the possibility to generate digital data with a wide range of output levels. For every 4 bit the LOW and HIGH levels can be programmed from -2.0 V up to +10.0 V. Even at high speeds you are not limited concerning the maximum output swing. This enables the user to drive devices of nearly any logic family, like ECL, PECL, TTL, LVDS, LVTTL, CMOS or LVCMOS. The potentially necessary differential signals are generated in hardware, so that only one data bit is used for each pair of differential signals. The on-board memory of up to 2 GByte can be used completely for recording or replaying digital data. Alternatively the M2i.70xx can be used in FIFO mode. Then data is transferred on-line from PC memory or hard disk. All boards of the M2i.72xx series may use the whole installed on-board memory completely for the currently activated number of channels.

*Some x16 PCIe slots are for the use of graphic cards only and can not be used for other cards.
Software Support

Windows drivers
The cards are delivered with drivers for Windows 7, Windows 8 and Windows 10 (each 32 bit and 64 bit). Programming examples for Visual C++, C++ Builder, LabWindows/CVI, Delphi, Visual Basic, VB.NET, C#, J#, Java and Python are included.

Linux Drivers
All cards are delivered with full Linux support. Pre compiled kernel modules are included for the most common distributions like Fedora, Suse, Ubuntu LTS or Debain. The Linux support includes SMP systems, 32 bit and 64 bit systems, versatile programming examples for GNU C++, Python as well as the possibility to get the driver sources for your own compilation.

S Bench
A full licence of SBench the easy-to-use graphical operating software for the Spectrum cards is included in the delivery. The version 6 is running under Windows as well as under Linux (KDE and GNOME).

Third-party products
Spectrum supports the most popular third-party software products such as LabVIEW, MATLAB or LabWindows/CVI. All drivers come with detailed documentation and working examples are included in the delivery. Support for other software packages, like VEE or Da-sylab, can also be provided on request.

MI Software compatibility layer
To allow an easy change from MI cards to the new M2i cards for existing software a special software compatibility layer is delivered with the cards. This DLL converts MI calls to M2i calls and simulates a MI card in the software.

Hardware features and options

PCI/PCI-X
The cards with PCI/PCI-X bus connector use 32 bit and up to 66 MHz clock rate for data transfer. They are 100% compatible to Conventional PCI > V2.1. The universal interface allows the use in PCI slots with 5 V I/O and 3.3 V I/O voltages as well as in PCI- X or PCI 64 slots. The maximum sustained data transfer rate is 245 MByte/s per bus segment.

PCI Express
The cards with PCI Express use a x1 PCIe connector. They can be used in PCI Express x1/x4/x8/x16 slots, except special graphic card slots, and are 100% software compatible to Conventional PCI > V2.1. The maximum sustained data transfer rate is 160 MByte/s per slot.

FIFO mode
The FIFO mode is designed for continuous data transfer between measurement board and PC memory (up to 245 MB/s on a PCI-X slot, up to 125 MB/s on a PCI slot and up to 160 MB/s on a PCIe slot) or hard disk. The control of the data stream is done automatically by the driver on interrupt request. The complete installed on-board memory is used for buffer data, making the continuous streaming extremely reliable.

Singleshot output
When singleshot output is activated the data of the on-board memory is played exactly one time. The trigger source can be either one of the external trigger inputs or the software trigger. After the first trigger additional trigger events will be ignored.

Repeated output
When the repeated output mode is used the data of the on-board memory is played continuously for a programmed number of times or until a stop command is executed. The trigger source can be either one of the external trigger inputs or the software trigger. After the first trigger additional trigger events will be ignored.

Single Restart replay
When this mode is activated the data of the on-board memory will be replayed once after each trigger event. The trigger source can be either the external TTL trigger or software trigger.

Multiple Replay
The Multiple Replay mode allows the fast output generation on several trigger events without restarting the hardware. With this option very fast repetition rates can be achieved. The on-board memory is divided into several segments of the same size. Each segment can contain different data which will then be played with the occurrence of each trigger event.

Gated Replay
The Gated Sampling mode allows data replay controlled by an external gate signal. Data is only replayed if the gate signal has attained a programmed level.

Sequence Mode
The sequence mode allows to split the card memory into several data segments of different length. These data segments are chained up in a user chosen order using an additional sequence memory. In this sequence memory the number of loops for each segment can be programmed and trigger conditions can be defined to proceed from segment to segment. Using the sequence mode it is also possible to switch between replay waveforms by a simple software command or to redefine waveform data for segments simultaneously while other segments are being replayed. All trigger-related and software-command-related functions are only working on single cards, not on star-hub-synchronized cards.

External trigger I/O
All digital boards can be triggered using an additional external TTL signal per acquisition module. It's possible to use positive or negative edge also in combination with a programmable pulse width. An internally recognized trigger event can - when activated by software - be routed to the trigger output connector to start external instruments.

Pulse width
Defines the minimum or maximum width that a trigger pulse must have to generate a trigger event. Pulse width can be combined with channel trigger, pattern trigger and external trigger.
**External clock I/O**
Using a dedicated line a sampling clock can be fed in from an external system. It's also possible to output the internally used sampling clock to synchronize external equipment to this clock.

**Reference clock**
The option to use a precise external reference clock (typically 10 MHz) is necessary to synchronize the instrument for high-quality measurements with external equipment (like a signal source). It's also possible to enhance the stability of the sampling clock in this way. The driver automatically generates the requested sampling clock from the fed in reference clock.

**Singleshot output**
When singleshot output is activated the data of the on-board memory is played exactly one time. The trigger source can be either one of the external trigger inputs or the software trigger. After the first trigger additional trigger events will be ignored.

**Repeated output**
When the repeated output mode is used the data of the on-board memory is played continuously for a programmed number of times or until a stop command is executed. The trigger source can be either one of the external trigger inputs or the software trigger. After the first trigger additional trigger events will be ignored.

**Single Restart replay**
When this mode is activated the data of the on-board memory will be replayed once after each trigger event. The trigger source can be the external TTL trigger or software trigger.

**Star-Hub**
The star-hub is an additional module allowing the phase stable synchronisation of up to 16 boards in one system. Independent of the number of boards there is no phase delay between all channels. The star-hub distributes trigger and clock information between all boards. As a result all connected boards are running with the same clock and the same trigger. All trigger sources can be combined with OR/AND allowing all channels of all cards to be trigger source at the same time. The star-hub is available as 5 card and 16 card version. The 5 card version doesn’t need an extra slot.

**271 synchronous cards with the System Star-Hub**
With the help of multiple system star-hubs it is possible to link up to 17 system phase synchronous with each other. Each system can then contain up to 16 cards (master only 15). In total 271 cards can be used fully synchronously in a bunch of systems. One master system distributes clock and trigger signal to all connected slave systems.

**1-4 bits mode**
On all models it is also possible to use just 1, 2 or 4 bits for replay. In 1 bit mode the 8 times higher memory is then available, at 2 bits mode it is 4 times higher and at 4 bits mode it is double. This enlarges the replay time in on-board memory and it reduces the transfer rate when using FIFO mode. The data is stacked internally to 8 bit samples. Therefore all information on memory/segment/pre and posttrigger sizes and steps can be up to 8 times higher.

**BaseXIO (Asynchronous I/O, enhanced trigger)**
The BaseXIO option offers 8 asynchronous digital I/O lines on the base card. The direction can be selected by software in groups of four. This allows e.g. external equipment control or status monitoring. Two of these lines can also be used as additional external trigger sources. This allows the building of complex trigger conjunctions with external gated triggers as well as AND/OR conjunction of multiple external trigger sources like, for example, the picture and row synchronisation of video signals. In addition one of the I/O lines can be used as reference clock for the Timestamp counter.
Technical Data

Power Up
Data channels state after power up: tristate (high impedance)
Clock and trigger output after power up disabled

Digital Outputs
Output channels: software programmable
Output impedance: approximately 80 Ohm
Data signal level: programmable from -2.0 V up to +10.0 V
Programmable level accuracy: ±10 mV
Max output current per pin: 100 mA
Max output current per nibble (4 bit): 200 mA
Max output current per card: 500 mA (M2i.721x cards, otherwise no limit)
Rise/Fall time: 10% to 90%, 110 Ohm 2.0 ns (1 MS/s) up to 2.25 ns (40 MS/s)

Output Delays
Trigger to 1st sample: ≥ 8 active channels 18 clocks
Trigger to 1st sample: < 8 active channels 8 clocks + 10 * 8/active channels
Gate end to last replayed sample: 18 samples (≥ 8 active channels)
Gate end alignment: [32 / active channels] in samples

Trigger
Running mode: software programmable
Trigger modes: software programmable
Trigger edge: software programmable
Trigger pulse width: software programmable
Trigger delay: software programmable
Memory depth: software programmable
Posttrigger: software programmable
Multiple Repeat segment size: software programmable
Multiple Repeat, Gated Repeat: re-arming time ≥ 8 channels < 4 samples
Pretrigger at Multi, Gate, FIFO Recording: software programmable
Trigger output delay: 19 clocks
Internal/Internal trigger accuracy: ≥ 8 active channels 1 sample
Internal/Internal trigger accuracy: < 8 active channels 8/active channels samples (≤ 8 channels)
External trigger type (input and output): 3.3V LVTTL compatible (±5V tolerant)
External trigger input: Low ≤ 0.8 V, High ≥ 2.0 V, ≥ 8 ns in pulse stretch mode, ≥ 2 clock periods all other modes
External trigger input current sink: ±1.0 µA (no termination)
External trigger output levels: Low ≤ 0.4 V, High ≥ 2.4 V, TTL compatible
External trigger output drive strength: Capable of driving 110 Ω and 50 Ω load

Clock
Clock Modes: software programmable
Internal clock range (PLL mode): 1 kS/s to max using internal reference, 50kS/s to max using external reference clock
Internal clock accuracy: < 20 ppm
Internal clock setup granularity: ≤ 1% of range (100M, 10M, 1M, 100k, …)
External reference clock range: 1 MHz to 100 MHz, step size: 100k
External clock impedance: 110 Ω / high impedance (≥ 4 kΩ)
External clock range: DC up to max internal sample rate
External clock delay to internal clock: 5.4 ns
External clock type/edge: 3.3V LVTTL compatible, rising edge used
External clock input: Low ≤ 0.8 V, High ≥ 2.0 V, duty cycle: 45% - 55%
External clock maximum voltage: 0.5 V up to ±5.5 V (internacly clamped to 5.0V, 100 mA max. clamping current)
External clock output levels: Low ≤ 0.4 V, High ≥ 2.4 V, TTL compatible
External clock output drive strength: Capable of driving 110 Ω and 50 Ω load
External clock input current sink: ±1.0 µA (no termination)
Synchronization clock divider: software programmable

Sequence Replay Mode
Number of sequence steps: software programmable 1 up to 512 (sequence steps can be overloaded at runtime)
Number of memory segments: software programmable 2 up to 256 (segment data can be overloaded at runtime)
Loop Count: software programmable 1 to 1M loops
Sequence Step Commands: software programmable Loop for #Loops, Next, Loop until Trigger, End Sequence
Special Commands: software programmable Data Overload at runtime, sequence steps overload at runtime
**BaseXIO Option**

- **BaseXIO modes**: software programmable
- **BaseXIO direction**: software programmable
- **BaseXIO input**: Asynch digital I/O, 2 additional triggers, timestamp reference clock, timestamp digital inputs
- **BaseXIO input impedance**: 4.7 kOhm towards 3.3 V
- **BaseXIO input maximum voltage**: -0.5 V up to +5.5 V
- **BaseXIO output type**: TTL compatible: Low ≤ 0.8 V, High ≥ 2.0 V
- **BaseXIO output levels**: 3.3 V LVTLL
- **BaseXIO output drive strength**: 32 mA maximum current, no 50 Ω loads

**Connectors**

- **Digital Inputs/Outputs**: 40 pole half pitch (Hirose FX2 series) Connector on card: Hirose FX2B-40PA-1.27DSL Flat ribbon cable connector: Hirose FX2B-40SA-1.27R
- **Option BaseXIO**: 8 x 3 mm SHB male on extra bracket, internally 8 x MMCX female

**Environmental and Physical Details**

- **Dimension (PCB only)**: 312 mm x 107 mm (full PCI length)
- **Width (Standard or with option star-hub 5)**: 1 full size slot
- **Width (star-hub 16)**: additionally back of adjacent neighbour slots
- **Width (with option BaseXIO)**: additionally extra bracket on neighbour slot
- **Width (with option -digin, -digout or -60xx-AmpMod)**: additionally half length of adjacent neighbour slot
- **Weight (depending on version)**: 290g (smallest version) up to 460g (biggest version with all options, including star-hub)
- **Warm up time**: 10 minutes
- **Operating temperature**: 0°C to 50°C
- **Storage temperature**: -10°C to 70°C
- **Humidity**: 10% to 90%

**PCI / PCI-X specific details**

- **PCI / PCI-X bus slot type**: 32 bit 33 MHz or 32 bit 66 MHz
- **PCI / PCI-X bus slot compatibility**: 32/64 bit, 33-133 MHz, 3,3 V and 5 V I/O
- **Sustained streaming mode**: > 245 MB/s (in a PCI-X slot clocked at 66 MHz or higher)

**PCIe Express specific details**

- **PCIe slot type**: x1 Generation 1
- **PCIe slot compatibility**: x1/x4/x8/x16 (Some x16 PCIe slots are for graphic cards only and can not be used)
- **Sustained streaming mode**: > 160 MB/s

**Certification, Compliance, Warranty**

- **EMC Immunity**: Compliant with CE Mark
- **EMC Emission**: Compliant with CE Mark
- **Product warranty**: 5 years starting with the day of delivery
- **Software and firmware updates**: Life-time, free of charge
**Power Consumption**

The setup and hold times as well as any delays relate to the output clock. If using external clock the timing depends on the used external range. Please be sure to meet this timing constraints if feeding in external clock.

For detailed information on the different modes for external clocking please refer to the dedicated chapter in the hardware manual for the boards of the M2i.72xx series.

**MTBF**

MTBF 200000 hours

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**External clock-to-data timing**

The setup and hold times as well as any delays relate to the output clock. If using external clock the timing depends on the used external range. Please be sure to meet this timing constraints if feeding in external clock.

For detailed information on the different modes for external clocking please refer to the dedicated chapter in the hardware manual for the boards of the M2i.72xx series.

When using external clock a delayed clock signal is generated on the Clock Output pin. The timing data in relation to this delayed clock output is similar to the timing when using internal clocking. It is therefore strongly recommend that you use the delay clock output for clocking any external devices.
Order Information

The card is delivered with 512 MByte on-board memory and supports standard acquisition and replay (scope, single-shot, loop, single re-start), FIFO acquisition/replay (streaming), Multiple Recording/Replay, Gated Sampling/Replay, Timestamps and Sequence Mode. Operating system drivers for Windows/Linux 32 bit and 64 bit, examples for C/C++, LabVIEW [Windows], MATLAB (Windows and Linux), LabWindows/CVI, .NET, Delphi, Java, Python and a Base license of the oscilloscope software SBench 6 are included. Drivers for other 3rd party products like VEE or DASYlab may be available on request.

One digital connecting cable Cab-d40-idec-100 is included in the delivery for every digital connection (each 16 channels).

### PCI Express (PCIe)

<table>
<thead>
<tr>
<th>PCI Express</th>
<th>PCI/PCI-X</th>
<th>Standard Mem</th>
<th>1 Bit</th>
<th>2 Bit</th>
<th>4 Bit</th>
<th>8 Bit</th>
<th>16 Bit</th>
<th>32 Bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2i.7210-exp</td>
<td>M2i.7210</td>
<td>512 MB</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td></td>
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<tr>
<td>M2i.7211-exp</td>
<td>M2i.7211</td>
<td>512 MB</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>10 MS/s</td>
<td>5 MS/s</td>
</tr>
<tr>
<td>M2i.7220-exp</td>
<td>M2i.7220</td>
<td>512 MB</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
</tr>
<tr>
<td>M2i.7221-exp</td>
<td>M2i.7221</td>
<td>512 MB</td>
<td>40 MS/s</td>
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<td>40 MS/s</td>
<td>40 MS/s</td>
<td>40 MS/s</td>
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</table>

### Memory

<table>
<thead>
<tr>
<th>Order no.</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2i.xxxx-1GB</td>
<td>Memory upgrade to 1 GB of total memory</td>
</tr>
<tr>
<td>M2i.xxxx-2GB</td>
<td>Memory upgrade to 2 GB of total memory</td>
</tr>
</tbody>
</table>

### Options

<table>
<thead>
<tr>
<th>Order no.</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2i.xxxx-SH5 (1)</td>
<td>Synchronization Star-Hub for up to 5 cards, only 1 slot width</td>
</tr>
<tr>
<td>M2i.xxxx-SH16 (1)</td>
<td>Synchronization Star-Hub for up to 16 cards</td>
</tr>
<tr>
<td>M2i.xxxx-SSH16 (1)</td>
<td>System-Star-Hub Master for up to 15 cards in the system and up to 17 systems, PCI 32 Bit card, sync cables and extra bracket for clock and trigger distribution included</td>
</tr>
<tr>
<td>M2i.xxxx-SSH5M (1)</td>
<td>System-Star-Hub Slave for 5 cards in one system, one slot width all sync cables + bracket included</td>
</tr>
<tr>
<td>M2i.xxxx-SSHMe (1)</td>
<td>System-Star-Hub Slave for 16 cards in system, two slots width, all sync cables + bracket included</td>
</tr>
</tbody>
</table>

### Cables

<table>
<thead>
<tr>
<th>for Connections</th>
<th>Length</th>
<th>Order no. to BNC male</th>
<th>to BNC female</th>
<th>to SMA male</th>
<th>to SMA female</th>
<th>to SMB female</th>
</tr>
</thead>
<tbody>
<tr>
<td>BaseXIO line</td>
<td>80 cm</td>
<td>Cab-3f-9m-80</td>
<td>Cab-3f-9f-80</td>
<td>Cab-3f-3mA-80</td>
<td>Cab-3f-3mA-80</td>
<td>Cab-3f-3f-80</td>
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<tr>
<td>BaseXIO line</td>
<td>200 cm</td>
<td>Cab-3f-9m-200</td>
<td>Cab-3f-9f-200</td>
<td>Cab-3f-3mA-200</td>
<td>Cab-3f-3mA-200</td>
<td>Cab-3f-3f-200</td>
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</table>

### Software SBench6

<table>
<thead>
<tr>
<th>Order no.</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBench6</td>
<td>Base version included in delivery. Supports standard mode for one card</td>
</tr>
<tr>
<td>SBench6-Pro</td>
<td>Professional version for one card: FIFO mode, export/import, calculation functions</td>
</tr>
<tr>
<td>SBench6-Multi</td>
<td>Option multiple cards: Needs SBench6-Pro. Handles multiple synchronized cards in one system</td>
</tr>
</tbody>
</table>

### Software Options

<table>
<thead>
<tr>
<th>Order no.</th>
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</tr>
</thead>
<tbody>
<tr>
<td>SPc-RServer</td>
<td>Remote Server Software Package - LAN remote access for M2i/M3i/M4i/M4x/M2p cards</td>
</tr>
</tbody>
</table>

### Technical changes and printing errors possible

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(1) : Just one of the options can be installed on a card at a time.
(2) : Third party product with warranty differing from our export conditions. No volume rebate possible.