Modern communications systems demand more information capacity, higher signal quality, greater security and digital data compatibility. Traditional AM and FM, while valuable modulation methods have proven inadequate to match today’s needs for high-volume traffic. With millions of cell phone subscribers gobbling up more voice/data bandwidth, the need for modulation methods that can efficiently transfer information in a reliable manner has become imperative. This has resulted in the rapid growth of the electronics and telecommunications industry which intern has put tremendous pressure on the industry to recruit highly skilled and knowledgeable engineers.

Keeping this in mind the Digital (IQ) Modulation Lab Station has been designed such that it provides the right platform for engineers to learn and have hands-on experience in understanding the measurements, using the analysis tools and finally knowing how these help in designing & testing.

The Complete I/Q Modulation Kit Comprises of:

1. **Two 33220A Function/Arbitrary waveform generators for generating realtime I/Q signals**
2. **N9310A RF Signal Generator**
3. **N9010A EXA Signal Analyzer**
4. **DSO/MSO6000 Series Oscilloscope**
5. **Visual Engineering Environment (VEE) Pro Measurement, Control and automation software**
6. **Vector Signal Analysis (VSA) Software**
# Parameters of Digital Modulation

## Flexible generation:
- User defined I/Q generation
- Programmable carrier frequency and amplitude (9 kHz to 3 GHz & –127 dBm to +13 dBm)
- Supports popular wireless communication standards like GSM & CDMA
- Supports a wide range of digital modulation such as MSK, FSK, BPSK, QPSK, QAM etc
- Supports analog modulation such as AM, FM and PM as well

## Versatile analysis:
- Capture & view I/Q signals in time domain
- Capture analyze and demodulate the baseband & RF signals
- Vector Signal Analysis using oscilloscope or spectrum analyzer
- VEE Pro signal generation software for automatic configuration and generation of signals
- Flexible spectrum analyzer based demodulation for analog modulation as well

### Standard
- GSM
- DECT
- PHS
- CDMA
- User

### Data pattern
- PRBS
- User

### Modulation format
- BPSK
- QPSK
- 8PSK
- 16QAM
- 32QAM
- 64QAM
- 256QAM
- MSK
- FSK

### Filter
- RC
- RRC
- RECT
- GAUS
- None

### Impairment
- Noise
- Interference
- IQ rotation
- Etc

### Other parameters
- Symbol rate
- RF frequency
- RF amplitude
- Hardware
- Platform
Some of the Functionalities Offered by the Agilent I/Q Modulation Kit:

**Transmission section:**

- Highly intuitive VEE user interface allows one to select various parameters and options through simple drop-down menus and also enter custom values to see the effect of various parameters on the final signal quality and measurements.

- Users can choose to generate signals either specific to communication standards or custom digital modulation formats. One can vary parameters such as symbol rate, samples per symbol, data pattern & voltage level for I & Q signals; frequency in Hz, amplitude in dBm & type of output, continuous, TDMA or burst, of the carrier. One can also select the filter type, filter roll-off, modulation type and also see various other signals/stages such as IF, filter data and clock of the transmitter or even noise. The N9310A signal generator, by itself, is capable of generating analog modulation schemes such as AM, FM & PM as well.

- The real power of the transmitter section lies in its capability of injecting impairments into the ideal signal that effectively simulates the changes that a modulated signal undergoes during transmission. Some of the impairments & errors that can be induced to simulate channel effects are – Wide Band Noise, I/Q Imbalance, I/Q offset, Quadrature error, I/Q Rotation, Interference & Quantization noise.

**Receiver section:**

- The receiver section has been divided into two different functional blocks. One, for viewing time domain and frequency domain information of the baseband signals, the other for viewing spectral content and analyzing modulation on the RF signals.

- Agilent I/Q modulation kit is the only integrated solution that uses the world famous, industry standard 89600A Vector Signal Analyzer software platform on both Agilent oscilloscopes & spectrum analyzers to provide a comprehensive set of measurement & analysis tools to deep dive into signals in the baseband & modulation domain.

- Analysis of Baseband I/Q:

  - Agilent DSO6000 series oscilloscopes are the most versatile scopes in the industry with the fastest waveform update rate and a whole set of application suits that help in analyzing signals. Viewing of baseband signals with 256 levels of intensity grading and excellent Math & FFT functions allow accurate frequency domain measurements on these signals as well. One can trigger the oscilloscope on data, pattern, pulse width etc to precisely capture baseband signals for analysis.

  - I/Q signals can be provided to the I & Q inputs of the N9310A RF signal generator. The digitally modulated RF signal can be analyzed on the EXA signal analyzer platform. Highly accurate measurements in the frequency domain of the modulated carrier can be performed through a single touch of a button such as occupied bandwidth, channel power, ACPR etc. Being the world’s fastest spectrum analyzer in its class, it is capable of capturing all the frequency components of even burst signals and also uses the time gating feature for capturing specific slots of signals like GSM. Apart from this, the EXA can run the 89600A VSA software to perform extensive vector analysis in the modulation domain like constellation plot, I/Q eye patterns, Spectrogram, CCDF etc.

Apart from being the ideal tool for tomorrow’s engineers to unravel the mysteries of today’s complex digital communication technology, this software controlled digital transmitter can provide the necessary signals to test receivers designed by students as part of their undergraduate project, research etc.
The Digital Modulation Lab Station is simple to set up and easy to use as shown below:

**Configuration Details**

<table>
<thead>
<tr>
<th>Product</th>
<th>Part number</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function generator</td>
<td>33220A</td>
<td>20 MHz Arbitrary waveform generator</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>33220A-001</td>
<td>10 MHz External Timebase Option</td>
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</tr>
<tr>
<td>Oscilloscope options</td>
<td>DSO6012A</td>
<td>2-channel, 100 MHz Oscilloscope</td>
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</tr>
<tr>
<td></td>
<td>MSO6012A</td>
<td>2+16-channel, 100 MHz Mixed Signal Oscilloscope</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>DSO6014A</td>
<td>4-channel, 100 MHz Oscilloscope</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>MSO6014A</td>
<td>4+16-channel, 100 MHz Mixed Signal Oscilloscope</td>
<td>1</td>
</tr>
<tr>
<td>Software</td>
<td>86900SPC-HE1</td>
<td>VSA Edu version; 15 seats + 1 instructor copy</td>
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</tr>
<tr>
<td></td>
<td>W1141B-PRO</td>
<td>VEE Pro 8.5</td>
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<tr>
<td>Signal generator</td>
<td>N9310A</td>
<td>RF Signal generator, 9 KHz to 3 GHz</td>
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</tr>
<tr>
<td></td>
<td>N9310A-001</td>
<td>Analog I/O input capability</td>
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<tr>
<td>Signal analyzer</td>
<td>N9010A</td>
<td>EXA Spectrum Analyzer</td>
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<tr>
<td></td>
<td>N9010A-503</td>
<td>EXA Frequency range, 9 kHz to 3.6 GHz</td>
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</tr>
</tbody>
</table>
Two 33220A waveform generators can be synchronized through external time base references to accurately generate I & Q modulating signals.

- Generate standard, custom and pulsed signals up to 20 MHz
- 64K Points of memory for generating custom I/Q signals with accurate phase synchronization
- Continuous and burst modes for generating various standard wireless signals
- USB, GPIB and LAN provide versatile and easy connectivity to PC

A fully featured Signal Analyzer that not only do accurate spectral analysis and complex frequency domain measurements but also runs the Vector Signal Analysis software to perform demodulation on modulated signals.

- Fastest spectrum & signal analyzer in its class with analysis from 9 KHz to 3.6 GHz with an analysis BW of 10 MHz
- Can work as swept tuned receiver or in the FFT mode
- Performs Vector Signal analysis with the industry standard 89600A VSA software running in the signal analyzer
- Windows based with USB, GPIB & LAN connectivity options
- Flexible, upgrade able platform that can be customized for mobile WiMax, W-CDMA, Noise figure and other applications

Intuitive user interface and a plethora of pre-defined objects enable rapid program development and system customization

- Supports instruments with multiple connectivity options to be integrated in to one system; be it LAN, USB, RS-232 or VXI
- Inbuilt MATLAB® scripting allows use of MATLAB functions thus making processing and analysis easy for MATLAB users
- Predefined data structures and extensive driver compatibility makes program development easy and convenient for different types of programmers
- Large choice of prewritten example programs for instant instrument connectivity and system startup

Complex modulation schemes are being employed for optimum bandwidth utilization and these signals can be analyzed using Agilent VSA.

Demodulation of signals and the intricacies involved in measuring the critical parameters can be understood for a deeper insight in to communication systems.

This unique software, the only one of its kind in the industry, integrates seamlessly with the DSO/MSO6000 series oscilloscope. The scope captures the time domain signal whose frequency domain information and other parameters can be obtained by employing the VSA software on the captured waveform.
Configuration Options

<table>
<thead>
<tr>
<th></th>
<th>Basic</th>
<th>Enhanced</th>
<th>Advanced</th>
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</thead>
<tbody>
<tr>
<td>I/Q modulation</td>
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<td>•</td>
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</tr>
<tr>
<td>Base band signal analysis</td>
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<td>•</td>
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<tr>
<td>Base band signal demodulation analysis</td>
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<tr>
<td>RF signal analysis</td>
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</tr>
<tr>
<td>RF signal demodulation analysis</td>
<td></td>
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</tr>
</tbody>
</table>

VEE software

VSA software

Arb waveform generator: 33220A

Oscilloscope: 6000 Series

RF signal generator: N9310A

Signal analyzer: EXA

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To learn more about the Agilent Digital Modulation Lab Station and instruments, please visit www.agilent.com/find/iqmod
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