Modulation Systems – MPM Showcase

Conoptics Ti: Sapphire Intensity Control for Multi-Photon Microscopy (MPM)

CONOPTICS' a pioneer in the manufacturing of optics and laser accessories has developed a solution for Multi-Photon Microscopy (MPM).

Multiphoton fluorescence microscopy is a powerful research tool that combines the advanced optical techniques of laser scanning microscopy with long wavelength multiphoton fluorescence excitation to capture high-resolution, three-dimensional images of specimens tagged with highly specific fluorophores.

Conoptics' Model 350-80LA with BK (resonance-dampened) Option is a KD*P Series Electro-Optic modulator. When configured with our Model 302RM amplifier offers the ability to control laser intensity as well as high-speed shuttering. In addition, this solution can control beam attenuation and fly-back blanking with minimal dispersion and full modulation over the lasers bandwidth. The system operates center in/out with no spatial dispersion and rise/fall times of 1 micro-second.

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Modulator Key Features:

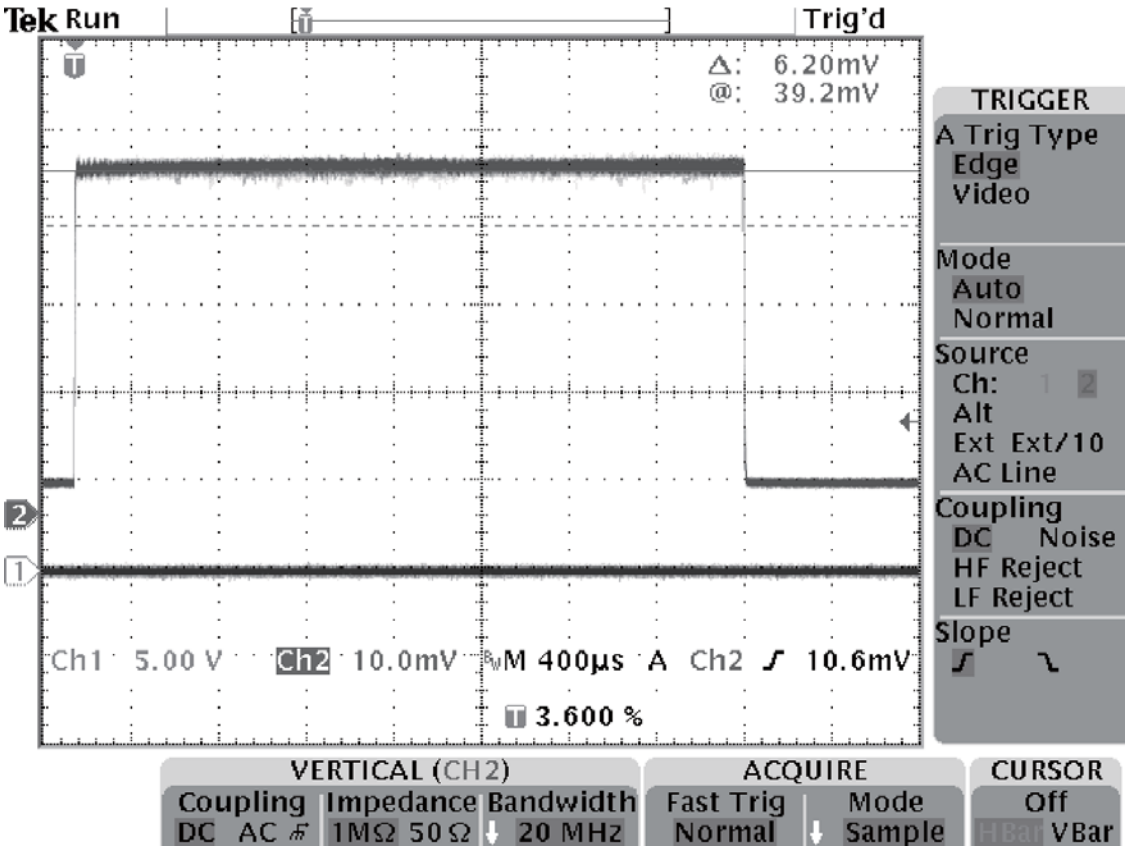
Aperture	3.5mm
Dimensions	50mm Diameter x 135mm
Transmission	>90%
Standard Wavelength Ranges	700 – to – 1100nm
Piezo Resonances	Minimal with clamped version (BK option)
Driver Compatibility	Full modulation with M302 Power Amplifier up to 1064nm

Amplifier Key Features:

Cabinet	Driver and power supply in single cabinet
Test Feature	Built-in test feature allows testing for max transmission of Pockel Cell without adjusting bias voltage
Input Impedance	Choice of amplifier input impedance by rear panel switch (50ohm/1K ohm)
DC Bias	Improved DC biasing of Pockel Cell provides greater linearity at higher bias voltages
Voltage Range	+/- 450VDC controlled by ten-turn front panel pot. Digital meter monitors differential bias applied to E.O. Modulator
Linearity	10bits referenced to full scale (.1%)
Bandwidth	DC to >200Khz with 90pf load and 3M (RG-62) cables
Max. Output Drive Level	750VP-P into 90pf load
Amplifier Input Signal	2VP-P max into 50/1K ohms delivers 750VP-P out
Input Signal Format	Options include Unipolar positive, negative or bipolar
Input Power (AC)	60W typical. Input power is both load (modulator) and frequency dependent.
Dimensions	19” Rack Mountable, 5.25”H(133mm) (3U) x 14”D (356mm)
Cooling	Forced air
Operating Environment	Designed for laboratory use (indoor only) Temperature range +5deg C to +50deg C ambient Humidity 20%-80% RH up to 32deg C Altitude <3000M
Weight	20lbs (9.07kg)

Output Response

The image below provide detected response at 514nm, 3ms pulse width, 250Hz rate



Dedication to the advancement of MPM

Conoptics is dedicated to the advancement of laser technology. The link below provides additional information on our collaboration with Cornell on MPM.

http://www.drbio.cornell.edu/Infrastructure/Apparatus_WWW/Conoptics.html

For additional information on our MPM solution or any of our product line please contact sales@conoptics.com.

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Electro-Optic Components and Systems

Choose from our line of modulators and driver electronics

Conoptics manufactures an extensive line of low voltage electro-optic light modulators, driver electronics and associated components to satisfy your diverse requirements. Your application will dictate which version of modulator and driver electronics you need and what auxiliary components you should use. The technical tables listed here provide detailed information to assist in your decision making process.

Modulation Systems Configuration Options

Conoptics manufactures a line of laser accessories for laser modulation, driver electronics, beam deflectors, noise reduction and optical isolators. All electro-optic modulators listed in this data sheet are of the transverse field type, that is, the electric field produced by the applied signal voltage is perpendicular to the optical propagation direction. The voltage swing required by a given modulator at a given operating wavelength to transit between the full off state to the full on state is called the Half Wave Voltage (V½).

Electro-Optic Modulators

All electro-optic modulators listed in this data sheet are of the transverse field type, that is, the electric field produced by the applied signal voltage is perpendicular to the optical propagation direction. The voltage swing required by a given modulator at a given operating wavelength to transit between the full off state to the full on state is called the Half Wave Voltage (V½). The transverse field structure allows reduction of V½ by manipulation of the crystal length to aperture ratio to a level achievable by available driver electronics. V½ is roughly proportional to wavelength and long wavelength devices usually require higher length to aperture ratios to accommodate existing driver output levels. Conoptics offers modulators constructed with three different crystal species: Ammonium Dihydrogen Phosphate (ADP), Potassium Dideuterium Phosphate (KD*P), and Lithium Tantalate (LTA). Models 370, 380, and 390 utilize ADP as the active element. The unique feature of these models is the virtual non-existence of piezoelectric resonances. Models belonging to the 360 series utilize LTA. LTA has the lowest intrinsic V½ and the longest wavelength IR cutoff.

Furthermore, it has a combination of high refractive index and relatively low dielectric constant which allows modulators to be designed which make full use of the intrinsic driver frequency response. Models in the 360 series exhibit piezoelectric resonances but they are discrete and very narrow. KD*P is used in Model 350 series modulators. In terms of optical transmission

bandwidth and driver frequency response utilization, this series falls in between ADP and LTA versions. Table 1 below provides the specifications our ADP (240-to-800nm), KD*P (240-to-1100nm) and LTA (700-2000nm) series modulator product line.

ADP Crystal Series Wavelength Limits (240 to 800 nm)*

Model Number	V ½ wave @ 500nm	V ½ wave @ 830nm	Aperture Diameter	Resonances	Contrast Ratio @ 633nm	Length w/ Polarizer
M370	184	306	2.5mm	No	500:1	158mm
M370 LA	263	437	3.5mm	No	500:1	158mm
M380	92	153	2.5mm	No	500:1	253mm
M390	115	190	3.5mm	No	500:1	272mm

KD*P Crystal Series Wavelength Limits (240 to 1100nm)*

Model Number	V ½ wave @ 500nm	V ½ wave @ 830nm	V ½ wave @ 1064nm	Aperture Diameter	Resonances	Contrast Ratio @ 633nm and 1064nm	Length w/ Polarizer
M350-50	455	757	970	3.1mm	Yes	500:1,700:1	106mm
M350-80	261	433	522	2.7mm	Yes	500:1,700:1	137mm
M350-80LA	360	600	720	3.5mm	Yes	500:1,700:1	137mm
M350-105	226	376	472	3.1mm	Yes	500:1,700:1	162mm
M350-160	130	216	275	2.7mm	yes	300:1,500:1	215mm
M350-210	113	188	240	3.1mm	Yes	300:1,500:1	268mm

LTA Crystal Series Wavelength Limits (700 to 2000nm)

Model Number	V ½ wave @ 830nm	V ½ wave @ 1064nm	V ½ wave @ 2500nm	Aperture Diameter	Resonances	Contrast Ratio @ 1064nm	Length w/ Polarizer
M360-40	312	400	950	2.7mm	Yes	200:1	95mm
M360-80	143	183	430	2.7mm	Yes	100:1	137mm
M360-120	107	138	323	2.7mm	Yes	100:1	174mm
M360-160	71	92	215	2.7mm	Yes	100:1	215mm

Table 2 Amplifier Details

Model	Bandwidth	Rise/Fall Times	Max. Output V	Typical Drive Configuration	Output
25A	DC-to-25MHz	14ns	145	100 Ohms B.L.	Linear
25D	DC-to-30MHz	8ns	175	100 Ohms B.L.	Digital
50	DC-to-50MHz	7ns	90	50 Ohms B.L.	Linear
100	DC-to-100MHz	3.5ns	90	50 Ohms B.L.	Linear
200	10Khz-to-200MHz	2ns	170	50 Ohms S.E.	—
275	DC-to-8MHz	50ns	275	Lumped Capacitance	Linear
302RM	DC-to-250KHz	1 micro-sec	750	Lumped Capacitance	Linear
302A	DC-to-1MHz	350ns	350	Lumped Capacitance	Linear
307	DC-to-50KHz	8ns	800	Lumped Capacitance	Digital
505	5MHz-to- 100MHz	3.5ns	44	50 Ohms S.E.	—
550	20MHz-to- 500MHz	1.5ns	140	50 Ohms S.E.	—

Special Notes

- Contrast ratio measured with 1mm beam @ 1% point.
- Special Order wavelengths below 400nm are available, please contact sales@conoptics.com
- Special Clamped Version available to minimize piezo-electric resonances
- To determine the ½ wave voltage at your operating wavelength, compute the voltage listed and multiply by the ratio of the desired wavelength (i.e. M350-50 @ 700nm = 455 x 700nm / 500nm = 637 Volts)
- The last Digits of the Model Number for the 350 and 360 Series designate the total crystal path length in millimeters.

Drive Electronics

In general, the first application requirements considered in the choice of modulation system components are the information bandwidth and waveform requirement. The driver output voltage achievable is a function of amplifier bandwidth and, while this system parameter is not isolated from others, such as aperture diameter, operating wavelength, etc., it is normally the limiting parameter of the system.

Optical Modulators

All modulators listed in this data sheet are of the transverse field type, that is, the electric field produced by the applied signal voltage is perpendicular to the optical propagation direction. The voltage swing required by a given modulator at a given operating wavelength to transit between the full off state to the full on state is called the Half Wave Voltage (V½). The transverse field structure allows reduction of V½ by manipulation of the crystal length to aperture ratio to a level achievable by available driver electronics. V½ is roughly proportional to wavelength and long wavelength devices usually require higher length to aperture ratios to accommodate existing driver output levels. Conoptics offers modulators constructed with three different crystal species: Ammonium Dihydrogen Phosphate (ADP), Potassium Dideuterium Phosphate (KD*P), and Lithium Tantalate (LTA). Models 370, 380, and 390 utilize ADP as the active element. The unique feature of these models is the virtual non-existence of piezoelectric resonances. Models belonging to the 360 series utilize LTA. LTA has the lowest intrinsic V½ and the longest wavelength IR cutoff. Furthermore, it has a combination of high refractive index and relatively low dielectric constant which allows modulators to be designed which make full use of the intrinsic driver frequency response. Models in the 360 series exhibit piezoelectric resonances but they are discrete and very narrow. KD*P is used in Model 350 series modulators. In terms of optical transmission bandwidth and driver frequency response utilization, this series falls in between ADP and LTA versions. Table 1 below provides the specifications our ADP (240-to-800nm), KD*P (240-to-1100nm) and LTA (700-2000nm) series modulator product line.

Table 1 Modulator Specifications:

	Model Number	V ½ wave @ 500nm	V ½ wave @ 830nm	V ½ wave @1064nm	V ½ wave @2500nm	Aperture Diameter	Resonances	Contrast Ration @ 633nm and 1064nm	Length w/ Polarizer
ADP Crystal Series Wavelength Limits ***(240 to 800nm)****	M370	184	--	--	--	2.5mm	No	500:1,N/A	158mm
	M370 LA	263	--	--	--	3.5mm	No	500:1, N/A	158mm
	M380	92	--	--	--	2.5mm	No	500:1, N/A	253mm
	M390	115	--	--	--	3.5mm	No	500:1, N/A	272mm
*KD*P Crystal Series Wavelength Limits* ***(240 to 1100nm)****	M350-50	455	757	970	--	3.1mm	Yes **	500:1, 700:1	106mm
	M350-80	261	433	522	--	2.7mm	Yes	500:1, 700:1	137mm
	M350-80LA	360	600	720	--	3.5mm	Yes		137mm
	M350-105	226	376	472	--	3.1mm	Yes	500:1, 700:1	162mm
	M350-160	130	216	275	--	2.7mm	Yes	300:1, 500:1	215mm
	M350-210	113	188	240	--	3.1mm	Yes	300:1, 500:1	268mm
LTA Crystal Series Wavelength Limits ***(700 to 2000nm)***	M360-40	--	312	400	950	2.7mm	Yes	N/A, 200:1	95mm
	M360-80	--	143	183	430	2.7mm	Yes	N/A, 100:1	137mm
	M360-120	--	107	138	323	2.7mm	Yes	N/A, 100:1	174mm
	M360-160	--	71	92	215	2.7mm	Yes	N/A, 100:1	215mm

Special Notes

- Special Order wavelengths below 400nm are available, please contact sales@conoptics.com
- Special Clamped version available to minimize Piezo-electric resonances
- To determine the ½ wave voltage at your operating wavelength, compute the voltage listed and multiply it by the ratio of the wavelengths. (i.e. M350-50 @ 700nm = 455 x 700 / 500 = 637 Volts)
- The last digits of the Model Number for the 350 and 360 Series designate the total crystal path length in millimeters.

Modulator Modifications

Any of the modulators listed here can be used as a phase modulator by simply rotating the input polarization direction by 45°. This procedure makes one of the modulator half segments essentially inactive and doubles V½ (now the voltage required for a 180° phase shift). A factory modification can be made during construction which restores V½ to its original value. This modification precludes use of the device as an intensity modulator, however, and is irreversible.

Amplifier Specifications

Table 2 listed below provides the basic specifications of our line of amplifiers and the interface configuration to the modulators. All of our amplifiers include a DC Bias Supply with greater than +/- 250 volts for setting the modulators operating point. The lump capacitance amplifiers have (2) BNC cables driving the modulator push-pull. The 50 ohms S.E. configuration has (2) SMA connectors for driving a 50 ohm single ended modulator and a third connector (BNC) for DC Bias. The 100 ohm and 50 ohm balanced line configuration has (2) twinax connectors for driving a balanced line modulator and a third miniature twinax connector for the DC Bias.

Table 2 Amplifier Details

Model	Bandwidth	Rise/Fall Times	Max. Output V	Typical Drive Configuration	Output
25A	DC TO 25MHz	14ns	145	100 Ohms B.L.	Analog
25D	DC TO 30MHz	8ns	175	100 Ohm's B.L.	Digital
50	DC TO 50MHz	7ns	90	50 Ohms B.L.	Analog
100	DC TO 100MHz	3.5ns	90	50 Ohms B.L.	Analog
200	10KHz TO 200MHz	-	170	50 Ohms S.E.	-
275	DC TO 8MHz	50ns	275	Lumped Capacitance	Analog
302RM	DC TO 250KHz	1micro sec	750	Lumped Capacitance	Analog
302A	DC TO 1MHz	350ns	350	Lumped Capacitance	Analog
307	DC TO 50KHz	8ns	800	Lumped Capacitance	Digital
505	20 TO 100MHz	-	44	50 Ohms S.E.	-
550	50 TO 500MHz	-	140	50 Ohms S.E.	-

Modulation Systems

The modulators and drivers listed in this data sheet can be used in various combinations to form high performance, cost effective modulation systems. Table 3 shows the key performance characteristics of various combinations of standard driver electronics and modulators. The high frequency -3dB points may be limited either by the driver or the modulator. Rise and fall times are normally calculated as 0.35 divided by the -3dB bandwidth but, due to the compression caused by the sine squared transfer characteristic over its full on to off range, the optical rise and fall times of these systems is approximately 20% less.

Table 3 Modulation Systems:

Amplifier	Modulator	Bandwidth	Transmission at Longest wavelength
302RM	350-80LA	DC to 250KHz	85% @ 1040nm
302RM	350-50	DC to 250KHz	85% @ 830nm
302RM	350-80	DC to 250KHz	85% @ 1200nm
302A	350-105	DC to 1MHz	85% @ 830nm
307	350-50	DC to 50KHz	85% @ 900nm
505	360-80	20MHz to 100MHz	Phase Modulation
550	360-80	50 to 250MHz	85% @ 830nm
25A	350-160	DC to 25MHz	85% @ 600nm
25A	350-80	DC to 25MHz	85% @ 830nm
25D	350-160	DC to 30MHz	85% @ 700nm
25D	360-80	DC to 30MHz	85% @ 1064nm
50	380-2P	DC to 50MHz	85% @ 500nm
50	360-120	DC to 50MHz	85% @ 830nm
100	380-2P	DC to 100MHz	85% @ 500nm
100	360-120	DC to 100MHz	85% @ 830nm
200	350-80	10KHz to 200MHz	85% @ 350nm
200	350-160	10KHz to 100MHz	85% @ 600nm
200	360-80	10KHz to 200MHz	85% @ 830nm
275	350-105	DC to 8MHz	85% @ 650nm
275	350-160	DC to 8MHz	85% @ 1064nm

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