

CHAPTER 3 PHOTONICS

PULSE SELECTOR AND REGEN SWITCH



Synchronized switching systems ensure optimum performance. Conoptics provides a family of products specifically tailored for pulse selection or regenerative amplifier switching systems. Each system consists of an optical modulator, a modulator driver, and synchronization electronics. The low voltage design approach taken here reduces modulator drive levels by an order of magnitude compared to other methods. This feature makes switching rates to tens of MHz readily achievable and virtually eliminates EMI effects.

Pulse Selection Systems

SYSTEM		DRIVER PARAMETERS		MODULATOR PARAMETERS			
DRIVER	MODULATOR	MINIMUM PULSE WIDTH	MAXIMUM REP RATE	MAXIMUM WAVELENGTH	MINIMUM WAVELENGTH FOR 100% DYNAMIC SWING	APERTURE mm	DYNAMIC SWING AT MAXIMUM OPERATING WAVELENGTH
25D	350-160	18 / variable	20MHz	350nm	700nm	2.7	80%@1000nm
25D	360-80	18 / variable	20MHz	600nm	1000nm	2.7	37%@2500nm
25D	360-120	18 / variable	20MHz	600nm	1350nm	2.7	56%@2500nm
25D	360-160	18 / variable	20MHz	600nm	2000nm	2.7	93%@2500nm
307A	350-50	18 / variable	50KHz	350nm	850nm	3.1	95%@1000nm
307A-1	350-50	18 / variable	5KHz	350nm	850nm	3.1	95%@1000nm
307A	360-40	18 / variable	50KHz	700nm	2000nm	2.7	95%@2000nm
307A-1	360-40	18 / variable	5KHz	700nm	2000nm	2.7	95%@2000nm

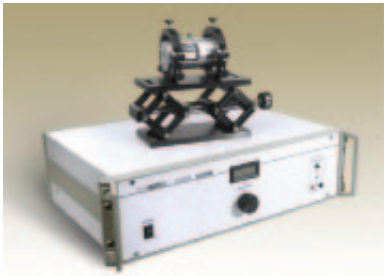
Please contact the factory for special configurations. Typical static insertion loss is 6%

Regen Switching Systems

SYSTEM	RISE TIME NSEC	MAXIMUM REP RATE	APERTURE mm	MAXIMUM WAVELENGTH SINGLE PASS	MAXIMUM WAVELENGTH DOUBLE PASS	PULSE WIDTH
307 / 350-50	5	50KHZ	3.1	880nm	1000nm	40 to 500 nsec
307 / 350-50LA	5	50KHz	5.7	450nm	900nm	40 to 500 nsec
25D / 350-105	8	20MHz	3.1	400nm	800nm	18 nsec to dc

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E-O MODULATOR



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 ($V_{1/2}$). The transverse field structure allows reduction of $V_{1/2}$ by manipulation of the crystal length to aperture ratio to a level achievable by available driver electronics. $V_{1/2}$ 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 $V_{1/2}$ 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.

	Model Number	$V_{1/2}$ wave @ 500nm	$V_{1/2}$ wave @ 830nm	$V_{1/2}$ wave @ 1064nm	$V_{1/2}$ wave @ 2500nm	Aperture Diameter	Resonances	Contrast Ratio @ 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
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 $1/2$ wave voltage at your operating wavelength, compute the voltage listed and multiply it by the ratio of the wavelengths. (i.e. M350-50 @ 700nm = $455 \times 700 / 500 = 637$ 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 $V_{1/2}$ (now the voltage required for a 180° phase shift). A factory modification can be made during construction which restores $V_{1/2}$ to its original value. This modification precludes use of the device as an intensity modulator, however, and is irreversible.

Amplifier Specifications

CHAPTER 3 PHOTONICS MODULATOR DRIVER

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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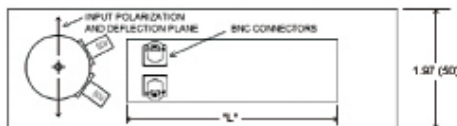
ELECTRO-OPTIC BEAM DEFLECTORS



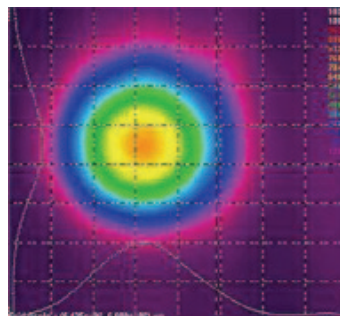
Conoptics series of electro-optic beam deflectors utilize a quadrupole electric field in an electro-optic material to produce a linear refractive index gradient proportional to the applied signal voltage. Choice of the proper material and crystallographic orientation eliminates piezoelectric ringing normally associated with other deflectors. There are no moving parts and they do not fatigue with prolonged use.

E-O Deflector				
SPECIFICATION	M310A	M311A	M312	M312-2
Deflection Efficiency micro-radians/volt	1.5	3.0	0.6	1.2
Usable Aperture, mm	2.5	2.5	2.7	2.7
Capacitance, pF *	100	185	50	100
Spectral Range **	400-750	400-750	400-1100	400-1100
Length, "L" (mm)	4.65 (118)	8.82 (218)	2.77 (71)	4.9 (125)

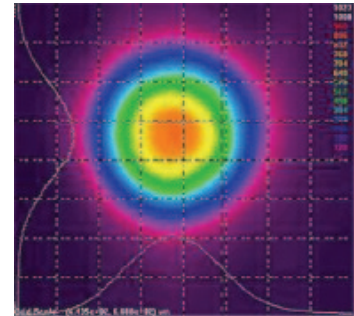
* Available as 2 Port version - 50 and 100 ohms
** UV and DUV options available



Beam Profile Laser Alone



Beam Profile with Deflector



Deflector Specifications

Dimensions	50mm Diameter x 20 mm long
Transmission	>90% 351//458
Aperture	<2.5 mm
Sensitivity	<2.63 microradians/volt (3 crystals) <0.875 microradians per volt (1 crystal)

M2100 Driver

Connected to 3 Crystal Port	0 to +/- 0.5 mrad
Access Time	<35 nsec
Bandwidth	<10kHz to 12 MHz
Input	<0 dbm (626mv P-P) signal must have net DC = zero waveform (50% duty cycle)
Dimensions	122 x 38.1 x 49.9 cm
Maximum Pulse Width (2% droop)	200 nsec
Static DC Bias Range	0 to 550v
Electrical Input Power	1.6 KW

Model 302 Driver

Connected to Single Crystal Port	0 to +/- 0.3 mrad; DC to 200 KHz
Access Time	<1 microsecond
Input Requirement	<2 Volts P-P
Input Impedance	<50 Ohms
Output Voltage	750 Volts P-P
-3 db Bandwidth	200 KHz
Driver Cabinet	6.5" W x 4.125" L x 4.15" H
Power Supply Cabinet	19" Rack x 5.25" H