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## GENERAL MODULATOR NOTES

### NOTES: P/N for modulators:

**1X series** are LT *Lithium Tantalate* (except Model 13LN [*Lithium Niobate*]), check power density table for these materials

**2X series** are ADP, DADP no longer available in standard units

**3XX series** are DKDP (KD\*P)

**4X series** are BBO

**No SUFFIX** – Amplitude modulator

**B SUFFIX** – BANANA JACKS

**BNC SUFFIX** – BNC CONNECTORS

**LA SUFFIX** – LARGE APERTURE

**NP SUFFIX** – POLARIZATION ROTATOR

**P SUFFIX** – Phase Modulator

**REMs** are LT, *Lithium Tantalate* (to 200MHz)

**UV SUFFIX** – UV region operation (350nm~200nm) – add 60%

NOTE: IMPEDANCED MATCHED DEVICES USE TRI-AX CONNECTORS, CAPACITIVE DEVICES USE BNC or BANANA CONNECTORS.

## OPTICAL WAVELENGTHS VS CRYSTAL MATERIAL

200nm ~ 400nm >>>> BBO

400nm ~ 800nm >>>> ADP

To 300nm as a custom unit >>>> ADP

300nm ~ 1064nm >>> KD\*P

800nm ~ 2500nm >>> Lithium Tantalate (LiTaO<sub>3</sub>)

## RELATIVE POWER CAPABILITY VS CRYSTAL MATERIAL

BBO >>>> High power >>>> 5 W/mm<sup>2</sup> @ 600nm  
ADP & KD\*P >>>> Medium power >>>> 3.5 W/mm<sup>2</sup> @ 600nm  
Lithium Tantalate >>> Low power >>>> 1 W/mm<sup>2</sup> @ 1000nm

# CRYSTAL APPLICATION USED IN MODULATORS

## **BBO**

The BBO crystal has good spectral range between 200nm and 400nm, and for this reason, it is used in these series modulators for these short wavelengths. Specifically, this crystal is used in Model **TWAP40**, a phase modulator, with a bandwidth to 500MHz. It consists of five BBO crystals with dimensions of each crystal being  $1 \times 1 \times 20 \text{mm}^3$ . The halfwave voltage required at 266nm is approximately 120V. BBO crystals exhibit the highest power threshold density at  $5 \text{ W/mm}^2$  @ 600nm. These crystals can be used at lower wavelengths; however, the halfwave voltage can become prohibitive.

**DATA SHEET 709**

## **ADP**

ADP is widely used in the spectral bandwidth of 400nm ~ 800nm. Its characteristic of no piezo-electric resonances for frequencies to 100MHz makes this material well suited for general applications, as well as, pulse picking and laser stabilization. When incorporated into the Quantum Technology Modulator Series 2X, it is available in three standard types: a) capacitive – response to 10MHz, b) 100-ohm impedance matched – response to 25~30MHz (depending on specific model), and c) 50-ohm impedance matched – response to over 50MHz. The transmission through its spectral bandwidth is ~85% on average.

**DATA SHEET 719**

## **KD\*P**

In general, this crystal has a broad spectral bandwidth with a range of 1064nm through 300nm. Because of this range, it can be double or triple coated to cover the fundamental, second and third harmonics of Nd:YAG lasers. It is particularly useful in the lower electrical bandwidths of less than 100KHz. Between 100KHz and 800KHz KD\*P exhibits some piezo-electric resonances, which may be unsuited in certain applications. These resonances are not excited when using short pulses such as for pulse picking and cavity dumping. The halfwave voltages are higher with KD\*P at the equivalent wavelengths than with the ADP modulators. These devices are available as capacitive, 100 or 50-ohm devices. Standard apertures are available at 2.5mm, 3mm, and 6mm. The transmission characteristics of KD\*P through its spectral bandwidth is over 90%. See Quantum Technology

**Data Sheet 752**

## Lithium Tantalate (LiTaO<sub>3</sub>)

This crystal's spectral bandwidth is broad into the NIR (near infrared) with a spectral response from 800nm to 2500nm. This crystal can go further into the infrared, but Lithium Tantalate has a "dip" at about 2900~3000nm, at which point, its transmission falls to below 10%. Beyond the 3000nm point, it can be useful to approximately 4000nm. These modulators are considered "specials". The broadband spectral transmission of Lithium Niobate averages 70%.

## LITHIUM NIOBATE

This material some use in the NIR (near infrared). It is used in "specials" for this application, and Quantum Technology can be contacted for further details.

## COMPARISON TABLE

<b>CHARACTERISTIC</b>	<b>BBO</b>	<b>ADP</b>	<b>KD*P</b>	<b>LT</b>
<b>SPECTRAL BANDWIDTH (Full Spectrum)</b>	400nm~200nm	400nm~(300nm-special) 800nm	300nm~1100nm	800nm~2500nm
<b>AVERAGE TRANSMISSION OVER SPECTRAL BANDWIDTH</b>	>90%	~85%	>90%	~70%
<b>TYPICAL DAMAGE THRESHOLD @ λ</b>	HIGH @ 600nm 5 W/mm <sup>2</sup>	MEDIUM @ 600nm 3.5 W/mm <sup>2</sup>	MEDIUM @ 600nm 3.5 W/mm <sup>2</sup>	LOW @ 1000nm 1 W/mm <sup>2</sup>
<b>TYPICAL HALF WAVE VOLTAGE @ λ - 10MHz unit capacitive unit (C-given)</b>	50-ohm Z matched	115V @ 633nm CLOAD = pF	150V @ 633nm CLOAD = 90pF	70V @ 633nm CLOAD = 57pF
<b>PIEZO-ELECTRIC RESONANCES</b>	Low <2%	NONE	~20% between 100KHz and 800KHz	
<b>STANDARD APERTURE RANGE</b>	1 mm	2.5mm ~ 3.5mm	2.5mm ~ 6mm	2.2 mm ~ 4.5mm
<b>RELATIVE COST</b>	HIGH TWAP-40 > \$ 27,000 w/driver 3100P	MODERATE \$1200 ~ \$ 7500	MODERATE \$ 1400 ~ \$ 5100	MODERATE \$ 3000 ~ \$ 5000
<b>APPROXIMATE LEAD-TIME from ARO to Shp.</b>	LONG >4 WEEKS	AVERAGE 3 TO 4 WEEKS	AVERAGE 3 TO 4 WEEKS	LONG >4 WEEKS
<b>GENERAL COMMENTS</b>	FOR USE IN NUV - NEAR ULTRA-VIOLET LIGHT	GENERAL PURPOSE FOR USE IN VISIABLE LIGHT WITH FAIR TRANSMISSION AND NO PIEZO-ELECTRIC EFFECTS	HIGHER TRANSMISSION IN VISIBLE LIGHT THAN ADP BUT WITH POSSIBLE PIEZO-ELECTRIC EFFECTS	FOR USE IN NIR - NEAR INFRARED LIGHT

The table below indicates the general electrical bandwidth of Quantum Technology Modulators.

MODEL	DC	1 MHz	10 MHz	15 MHz	30 MHz	50 MHz	100 MHz	550 MHz	1 GHz	5 GHz
TWAM/ P-10										
TWAM/ P-11										
12 SERIES										
Capacitive										
100-ohm										
50-ohm										
REM SERIES										
20 SERIES										
Capacitive										
100-ohm										
50-ohm										
300 SERIES										
Capacitive										
100-ohm										
50-ohm										
40 SERIES										
TWAP										