# Test Data Sheet

PM-Na23_1.7M3

(old: EO-Na23M3-VIS)

S/N:

Resonant electro-optic phase modulator

with
- tunable resonance frequency
- thermal crystal mount
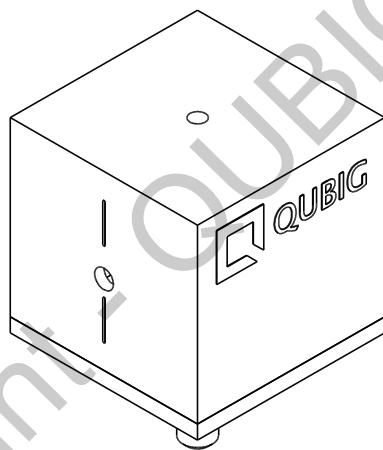
RF properties	Value	Unit
Resonance frequency: f_0 [1]	1464 – 1770	MHz
Preset frequency: f_{set} [1]	1713	MHz
Bandwidth: $\Delta\nu$	4.1	MHz
Quality factor: Q	418	
Required RF power for 1rad @ 589nm [2]	27.1	dBm
max. RF power: RF_{max} [3]	1	W

Optical properties		
EO crystal	MLN	
Aperture	3x3	mm²
Wavefront distortion (633nm)	$\lambda/4$	nm
recommended max. optical intensity (589nm)	<1	W/mm²
AR coating (R_{avg}<0.5%)	360 – 650	nm

[1] at 24°C [2] with 50Ω termination [3] no damage with RF_{in} < 3W

Fig. 1: Oscilloscope trace

f_0 = 1713. MHz
β = 0.99 rad
λ_{test} = 671 nm
RF_{in} = 28.4 dBm
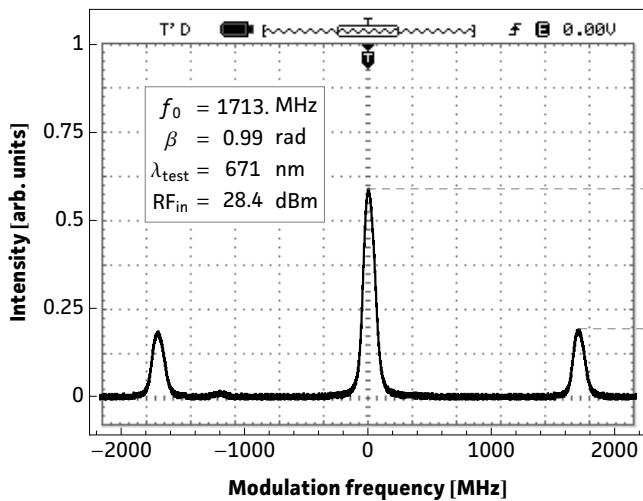
Fig. 2: Carrier/sideband ratio

Bessel Fct.
— $|J_0|^2$
— $|J_1|^2$
— $|J_2|^2$
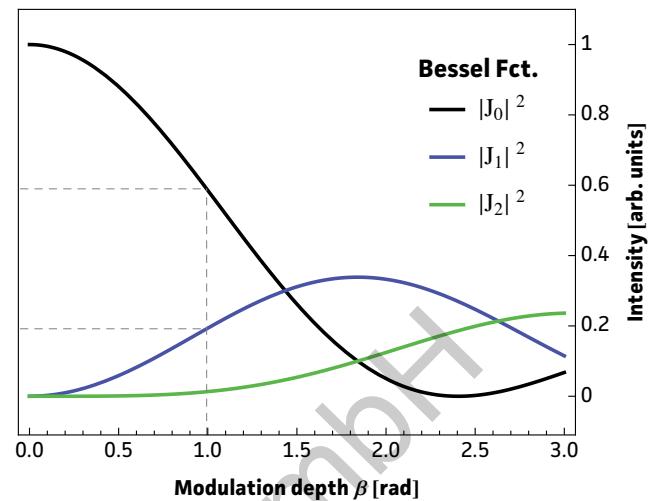
Table 1: Expected modulation

| $\beta = 1$ rad	unit	λ_1	λ_2
λ	nm	**589**	**671**
P	dBm	27.1	28.5
P	mW	513	701
U	V_p	7.2	8.4
U_π	V_p	22.5	26.3
β / U	rad / V	0.14	0.12

Fig.1: Recorded oscilloscope trace retrieved from a test setup as illustrated below.

Fig.2: Squared absolute values of first-kind Bessel functions vs. modulation depth. Vertical lines reveal the ratio between the carrier $|J_0|^2$ and the ith sideband $|J_i|^2$ at a specific ß.

Fig.3: Dependency between RF amplitude and modulation depth for different wavelengths. Points on the curve allow to retrieve either the required RF amplitude for a specific/desired ß or the max. achievable modulation depth for a given/available RF power.

Table 1: Expected RF-amplitude/-power values and conversion factors for the required wavelength at the reference modulation depth of 1 rad. **Note:** Experimentally recorded modulation depth displayed in Fig.1 might vary from the respective values (ß=1rad) provided in the table.


λ [nm]
— 671
— 589

Fig. 3: RF−signal amplitude vs. modulation depth

EOM

laser

spectrum analyzer

PD

Oscilloscope

RF

Test setup
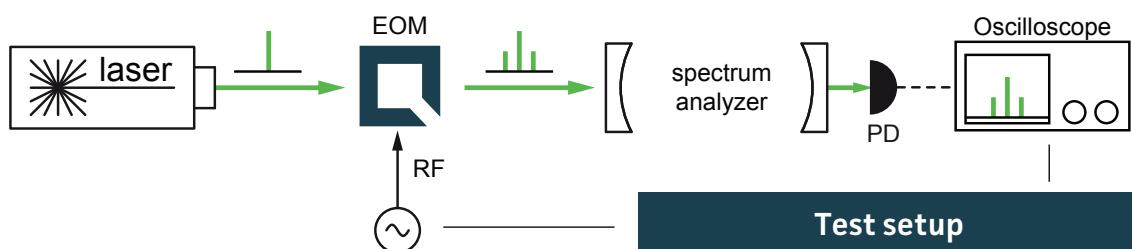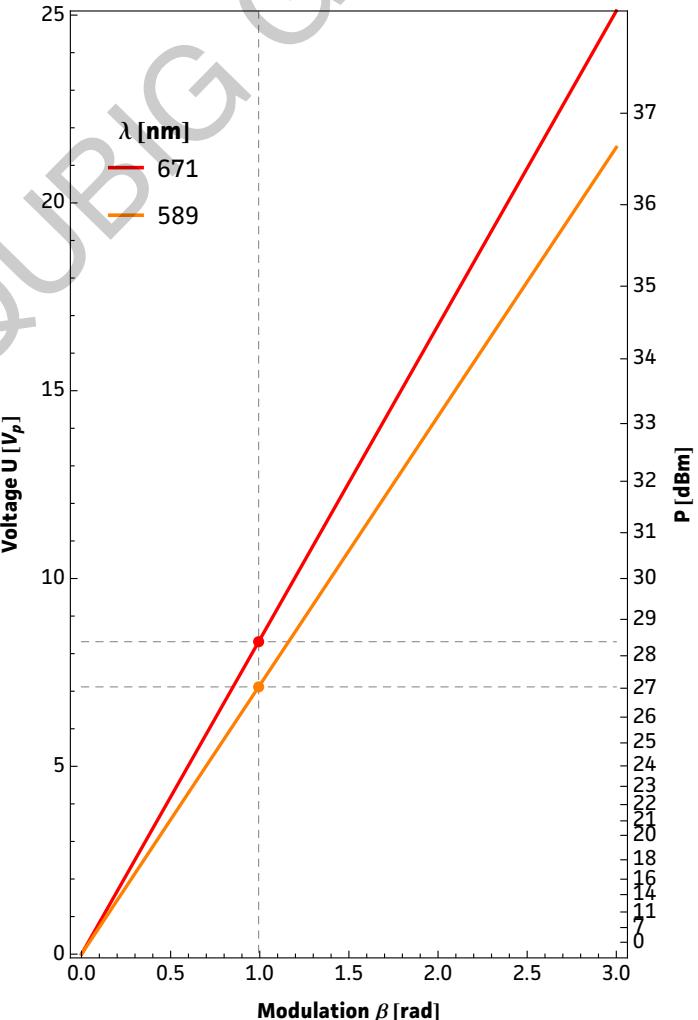
Resonance characteristics

Test setup

laser — +45° Glan-Thompson Polarizer — EOM — -45° Glan-Thompson Polarizer — PD — Vector Network Analyzer (Transmission / Return), RF sweep
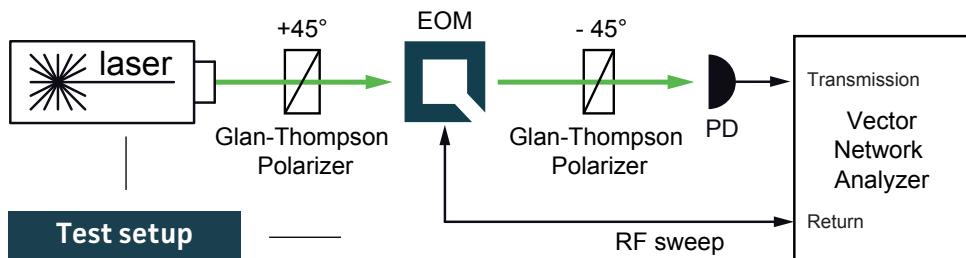
3/23/2018 1:20:41 PM
1328.5170K92-100178-Xi

Trc1 — S11 dB Mag 4.5 dB/ Ref -17.5 dB Cal int — 1

M1	1.712850 GHz	-22.9007 dB
M2	1.710861 GHz	-2.7294 dB
M3	1.714938 GHz	-3.3987 dB
M4	1.712898 GHz	-26.2187 dB

Ch1 Center 1.713 GHz Pwr 3 dBm Bw 1 kHz   Span 50 MHz

Trc3 — S21 dB Mag 3.5 dB/ Ref -37.5 dB Cal int — 2

Ref to Max	Track
Bandpass	
Bandwidth	4.076827 MHz
Center	1.712898 GHz
Lower Edge	1.710861 GHz
Upper Edge	1.714938 GHz
Quality Factor (3dB)	420.155 U
Loss	29.6888 dB

M1	1.712850 GHz	-29.6888 dB
M2	1.710861 GHz	-32.6888 dB
M3	1.714938 GHz	-32.6888 dB
M4	1.712898 GHz	-29.6979 dB

Ch1 Center 1.713 GHz Pwr 3 dBm Bw 1 kHz   Span 50 MHz

Trc4 — S11 Smith 200 mU/ Ref 1 U Cal int — 3

M1	1.712850 GHz	49.113 Ω
		-j7.060 Ω
		13.161 pF
M2	1.710861 GHz	27.833 Ω
		-j76.633 Ω
		1.214 pF
M3	1.714938 GHz	111.545 Ω
		j122.495 Ω
		11.368 nH
M4	1.712898 GHz	49.914 Ω
		-j4.897 Ω
		18.974 pF

Ch1 Center 1.713 GHz Pwr 3 dBm Bw 1 kHz   Span 50 MHz

Trc5 — S21 Phase unwrap 30°/ Ref -50° Cal int — 4

M1	1.712850 GHz	-65.97 °
M2	1.710861 GHz	-20.27 °
M3	1.714938 GHz	-115.23 °
M4	1.712898 GHz	-67.39 °

Ch1 Center 1.713 GHz Pwr 3 dBm Bw 1 kHz   Span 50 MHz

Tuning performance

MAX resonance frequency	f_0 max	1770	MHz
MIN resonance frequency	f_0 min	1464	MHz
number of turns	N_{max}	5	
counter clock-wise turns ↗	higher f_0 ↑		
clock-wise turns ↘	lower f_0 ↓		

Attention: No upper stop!!

--------- (# of turns: ccw) -------->

0 ... N_{max}
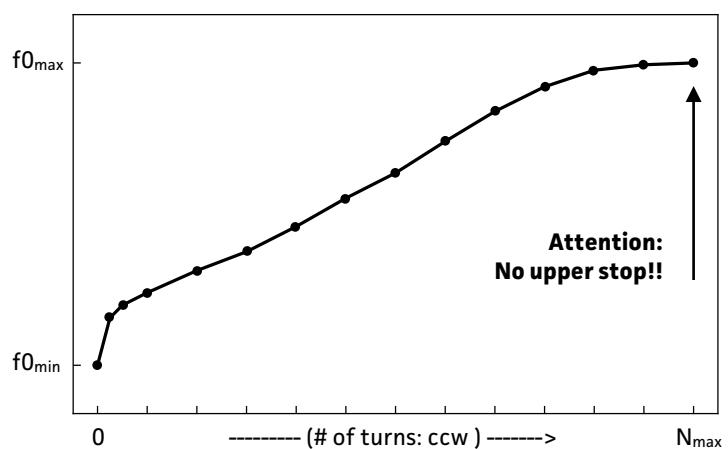
Handling instructions

- Input laser polarization must be aligned with respect to the white markers on the housing
- Please handle device carefully. Avoid shock. Don't drop.
- After turn on the resonance frequency might drift slightly with applied rf power. Please compensate by tuning the rf drive frequency until steady-state (~min).

Package drawing

8.5

40

31,5

M4x0.7 (max. 4mm) mounting option

20

0
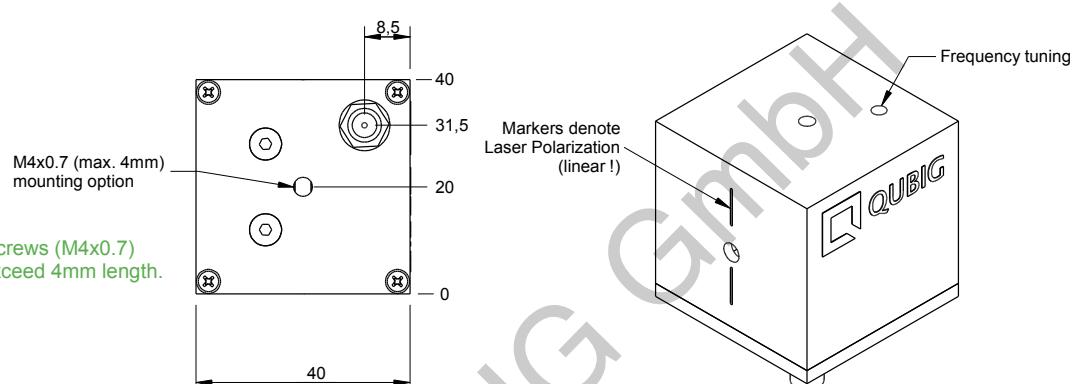
Note 1: mounting screws (M4x0.7) must not exceed 4mm length.

40

Frequency tuning

Markers denote Laser Polarization (linear !)

QUBIG

QUBIG

40

20

20

Ø 4
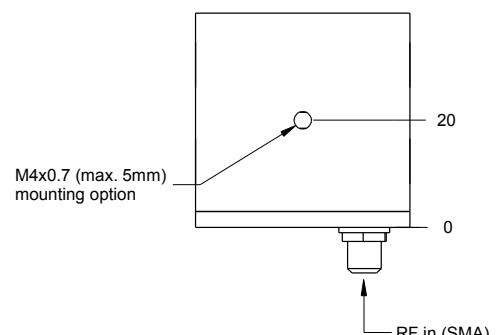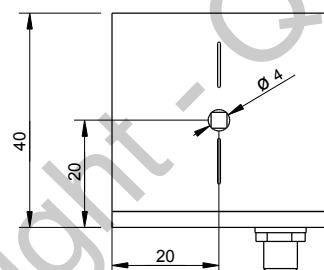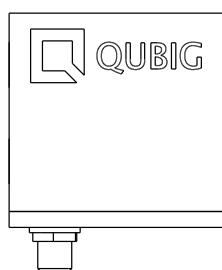
Note 2: crystal aperture is 3x3mm.

M4x0.7 (max. 5mm) mounting option

20

0

RF in (SMA)

M4x0.7 (max. 4mm) mounting option

Frequency tuning
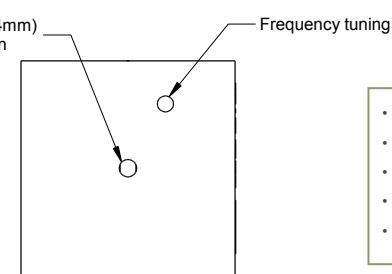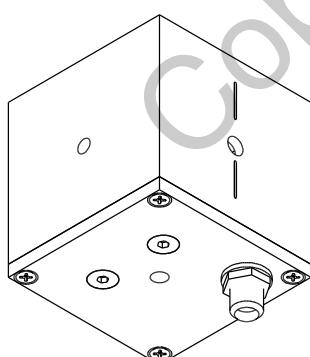
Attention!!

- use only supplied tuning tool
- actuate tuner carefully
- do not apply too much pressure or torque
- keep tuning tool coaxial
- tuner might not be perfectly orthogonal to box

Tested by:

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