Laboratory Verification of the SLR 2000 Quadrant Microchannel Plate Photomultiplier Tube

Howard Donovan, Mark Levy, John Hundertmark, Jeff Miller
NASA Satellite Laser Ranging Program
Lanham, Maryland 20706 USA

12th International Workshop on Laser Ranging
Matera, Italy
November 13-17, 2000
QMCP Mechanical Design

REMOVE ALL BURRS AND SHARP EDGES

AXES OF QUAD ANODE SEGMENTS IN LINE WITH MOUNTING HOLES.

34.00
32.50

5.50
3.00

6.80

ILV, POWER CONNECTOR

QUARTZ WINDOW REFRACTIVE INDEX 1.55 @ 300nm

GATE DRIVE CONNECTORS

4 HOLES 10/44.3 EQUISPAECED ON 75.00 PCB.

5.50

25.00

15.00

MATERIAL:

DRAWING No. A3/4143

TITLE

OUTLINE DRAWING

QUAD PNT 308 GA.
QMCP Mechanical Design
Quadrant Microchannel Plate (QMCP)

Features:

- Quadrant anode to facilitate pointing corrections
- Fast Rise Time ~ 180 ps
- Low Timing Jitter ~ 40 ps
- Low Timing Offset between quadrants ~ 8 ps
- 12% - 14% Quantum Efficiency @ 532nm
- $3 \times 10^6$ Gain
- 5 Vdc TTL Trigger Input
- Four Outputs
QMCP Laboratory Test Set Up
Laboratory Equipment

• Photek               GM 150-20 Gating Unit
• Opto Electronics    PLS20 Pulsed Diode Laser
• Opto Electronics    PD10 Picosecond Photodetector
• Avtech               AVRH-1-PS Pulse Generator
• Hewlett Packard     54120 Digital Sampling Oscilloscope
Laboratory Equipment Equipment and Parameter Measurement Values

• All equipment was within manufactures calibration specifications and within manufacturers calibration period

• QMCP Rise Time and Timing Jitter values were decoupled from individual rise time and timing jitter values of the pertinent laboratory equipment
QMCP Laboratory Test Set Up
Rise Time and Timing Jitter

Digital Delay Generator → Laser Control Unit → Pulsed Diode Laser → Gating Unit → MCP-PMT → HV Power Supply → Digital Sampling Oscilloscope
Rise Time Measurement

Purpose:

• Quantify the time of transition between the 10 percent and the 90 percent points on the leading edge of the QMCP output pulse
QMCP Rise Time

Range: 179 ps to 181 ps across 4 quadrants

Ch. 2 = 400.0 mVolts/div
Timebase = 200 ps/div
Ch. 2 Parameters
Rise Time = 507.4 ps
- Width = 360.8 ps
Fresheoot = 495.0 m\%
Timing Jitter Measurement

Purpose:

- Quantify the variation in the transit time of a receive signal through the QMCP as measured at the 50% point of the rising edge of the receive signal
QMCP Jitter

Range: 39 ps to 47 ps across 4 quadrants

Ch. 2 = 400.0 mVolts/div, Timebase = 50.0 ps/div, Delta Window = 150.00 mVolts, Window 1 = -400.00 mVolts, Delta % = 66.73 %, Upper = 83.97 %, Delta T = 19.2 ps, Start = 31.3845 ns, # Samples = 500, Mean = 31.3749 ns, Offset = -1.207 Volts, Delay = 31.3610 ns, Window 2 = -550.00 mVolts, Lower = 17.24 %, Stop = 31.3653 ns, Sigma = 9.6 ps
QMCP Spectral Response per Manufacturer

Serial Number: 42981001

Wavelength (nM) vs. QE (%) graph.
## QMCP Performance Matrix

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
<th>Tested Value</th>
<th>Tested Value</th>
<th>Test Method</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected Input to Detector</td>
<td>532 nm @ 2KHz</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Rise Time</td>
<td>&lt;125 ps all quadrants</td>
<td>Q1-178 ps</td>
<td>Q1-180 ps</td>
<td>Lab Measurement</td>
<td>Accepted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2-178 ps</td>
<td>Q2-179 ps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q3-172 ps</td>
<td>Q3-179 ps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q4-174 ps</td>
<td>Q4-181 ps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timing Offset</td>
<td>0 ps between all quadrants</td>
<td>6 ps</td>
<td>8 ps</td>
<td>Lab Measurement</td>
<td>Accepted</td>
</tr>
<tr>
<td>Timing Jitter at Anode (Method 1)</td>
<td>&lt;28 ps RMS on any quadrant,</td>
<td>Q1-34 ps</td>
<td>Q1-39 ps</td>
<td>Lab Measurement</td>
<td>Accepted</td>
</tr>
<tr>
<td></td>
<td>&lt;40 ps between any two</td>
<td>Q2-34 ps</td>
<td>Q2-42 ps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q3-37 ps</td>
<td>Q3-42 ps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q4-45 ps</td>
<td>Q4-47 ps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>3X10^6 with a Goal of 10X10^6</td>
<td>3.5X10^6 @ -4700</td>
<td>3X10^6 @ -4400</td>
<td>Manufacturers Data Sheet</td>
<td>Accepted</td>
</tr>
<tr>
<td>External Gating</td>
<td>&lt;20 ns turn-on</td>
<td>~3 ns</td>
<td>~3 ns</td>
<td>Lab Measurement</td>
<td>Accepted</td>
</tr>
<tr>
<td>Anode Output Connectors</td>
<td>Four SMA Connectors</td>
<td>Concur</td>
<td>Concur</td>
<td>Lab Observation</td>
<td>Accepted</td>
</tr>
<tr>
<td>Active Cathode Area</td>
<td>12 mm</td>
<td>8mm</td>
<td>8mm</td>
<td>Lab Measurement</td>
<td>Accepted</td>
</tr>
<tr>
<td>Anode Structure</td>
<td>Quadrant - 4 pie shaped wedges of 90 degrees each</td>
<td>Quadrant - 4 square shaped wedges</td>
<td>Quadrant - 4 square shaped wedges</td>
<td>Lab Measurement</td>
<td>Accepted</td>
</tr>
<tr>
<td>Quantum Efficiency</td>
<td>&gt;15% @ 532</td>
<td>12.59%</td>
<td>13.60%</td>
<td>Manufacturers Data Sheet</td>
<td>Accepted</td>
</tr>
<tr>
<td>High Voltage Bias Supply</td>
<td>External DC power supply</td>
<td>Concur</td>
<td>Concur</td>
<td>Lab Observation</td>
<td>Accepted</td>
</tr>
<tr>
<td>Mounting</td>
<td>Precision mounting with quadrant axis indexed</td>
<td>Concur</td>
<td>Concur</td>
<td>Lab Measurement</td>
<td>Accepted</td>
</tr>
</tbody>
</table>