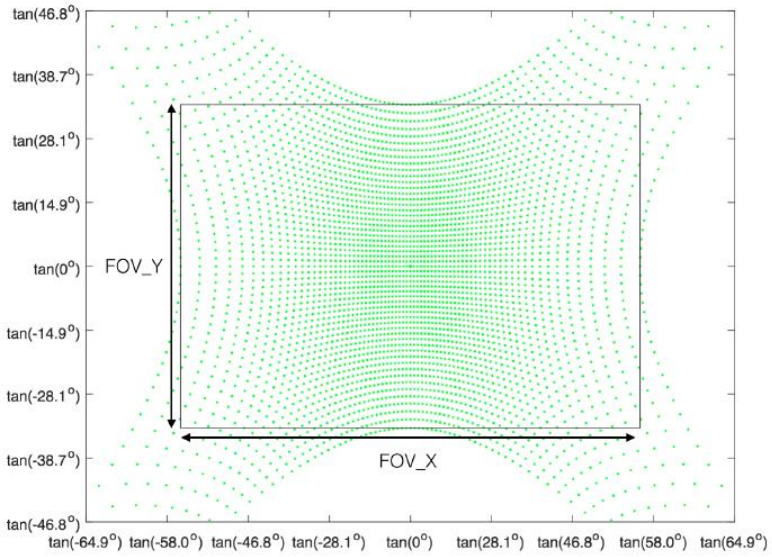
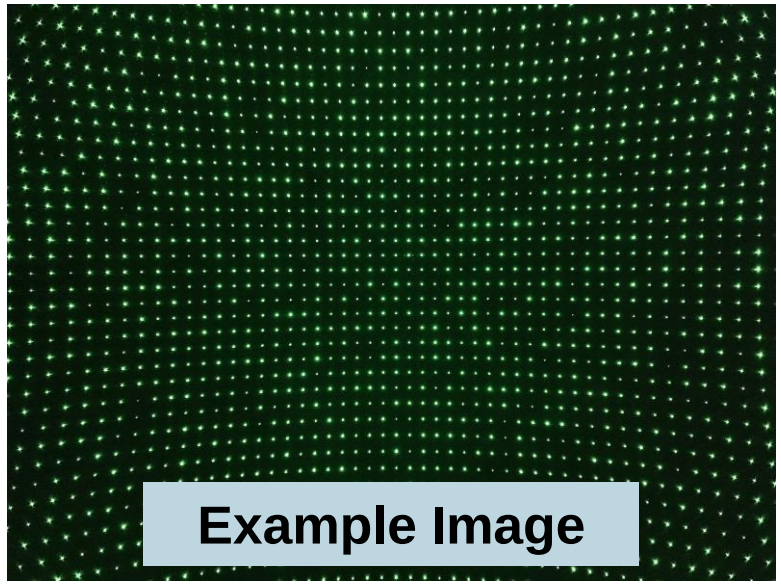
Tesseract XLHD System Introduction

Tesseract System Overview

- Tesseract is a diffractive optic based camera calibration tool that combines a single mode green laser source with a 2D beam splitting diffractive optical instrument
  - System operates at 532nm (green) nominal wavelength
  - Laser systems is Class 1 compliant (eye safe)
  - Illuminator optics project an infinite conjugate spot pattern
  - System is extremely robust to environmental inputs (shock, vibe, temperature)
    - Operational temperature window: 18-38C
    - No moving parts except cooling fans on laser module heatsinks





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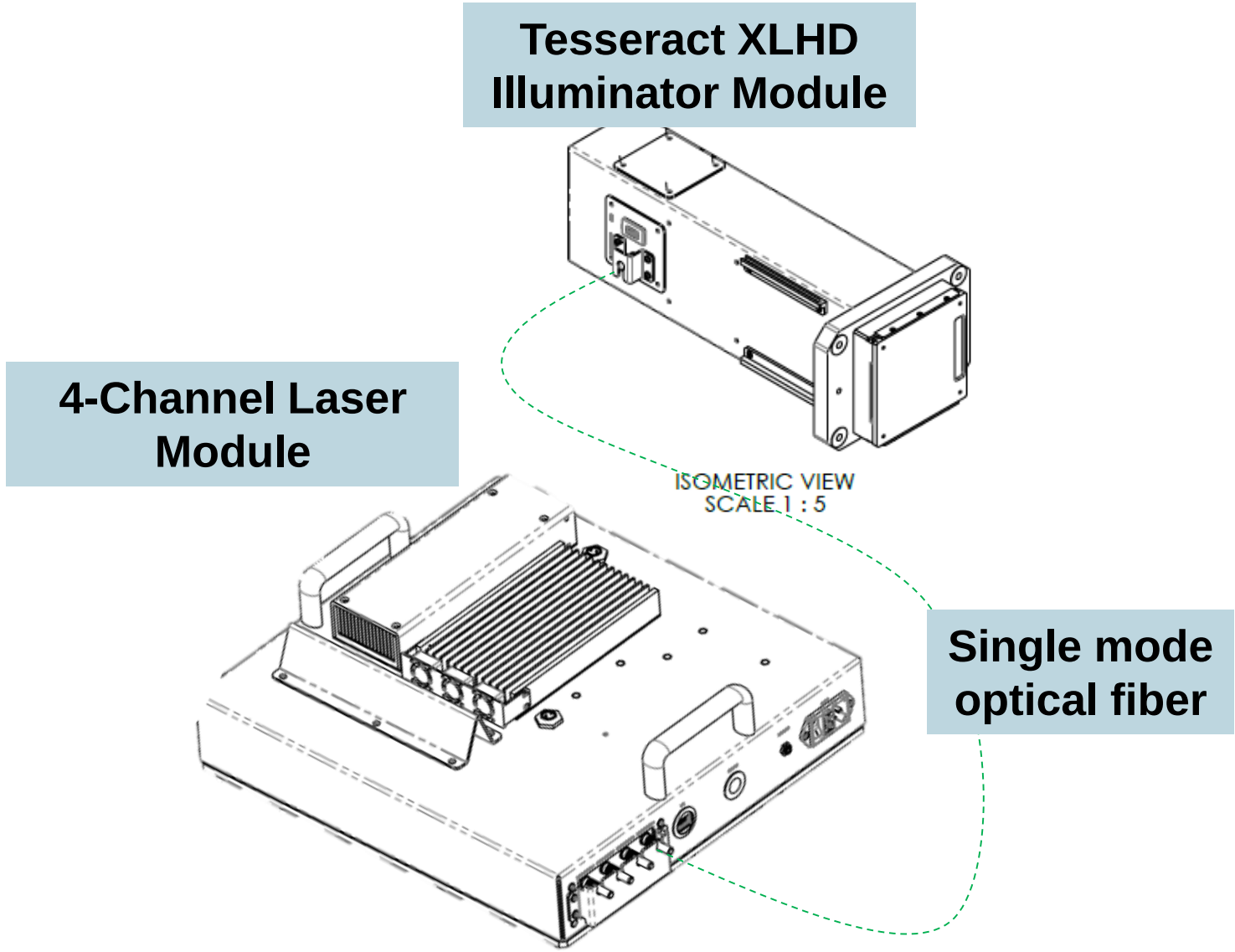
Tesseract XLHD Components

- Tesseract XLHD optical components are designed for scalable camera calibration applications
  - Split system with separate 4-channel laser module and more compact Illuminator modules
    - One laser can supply 4 Illuminators for multi-up station architecture
  - Dedicated QC Tools exist periodic audit and IQC in large quantity deployments
  - Generally kept in stock at Quartus in low quantities (~QTY 5)
  - Laser module unit price $13,838; Illuminator module unit price $8440



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Camera Calibration Image Processing

- With known laser wavelength, diffraction order spacing, and low illumination wavefront error, the system will allow for precise camera calibration solution
- Because system provides infinite conjugate projection, images are not sensitive to camera decenter as long as camera stays within "eyebox" of the Illuminator
- Standard calibration outputs:
  - Intrinsic parameters:
    - Practical Focal Length (PFL) in x and y, units of pixels
    - Principal point (PP) in x and y, units of pixels
    - Distortion polynomial coefficients (Kannala Radial 4-term is standard)
  - Extrinsic parameters
    - 3 Degree of Freedom (DOF) angular pose of camera relative to Illuminator
    - Epipolar error of multiple cameras
  - Required initial conditions for model solver:
    - Nominal focal length (pixels)

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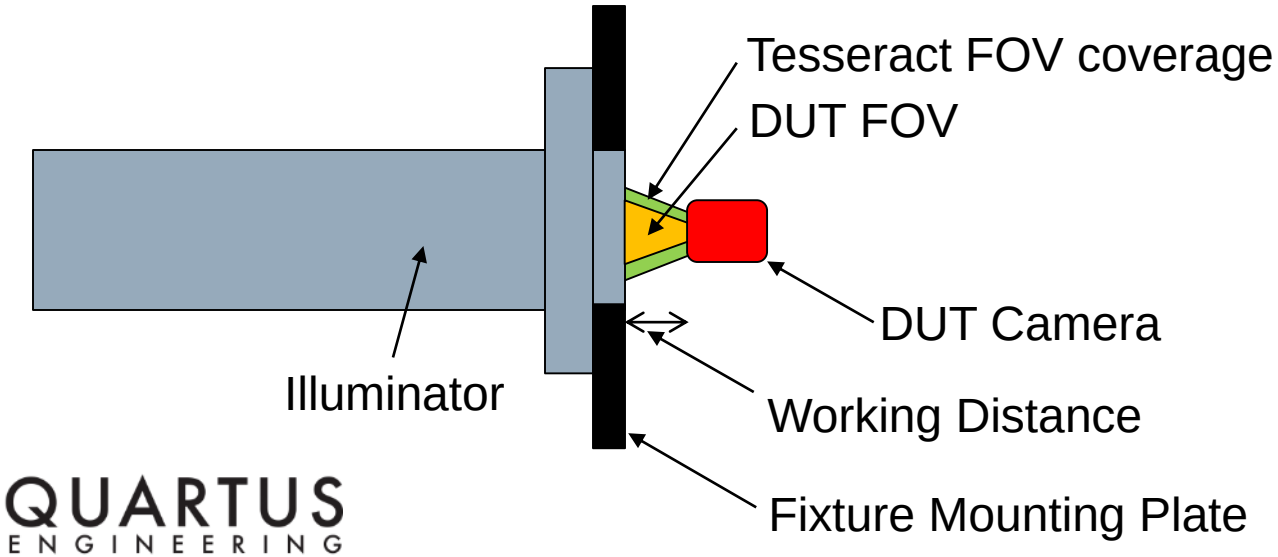
Basic Tesseract Setup

- Tesseract XLHD optical have a 50mm clear aperture output
- Diffractive pattern will cover >130 degree diagonal FOV
- Working distance is typically quite short depending on FOV
  - Camera Device Under Test (DUT) FOV and aperture position will determine maximum working distance
  - DUT should nominally be centered on optical axis of Tesseract but can be offset as needed for multiple camera systems



Parameters	NFOV (Eagle)	MFOV (Falcon)
EFL (mm)	15.34	5.44
f/#	1.6	1.6
Sensor	8.3MP 3840x2160 pixels, 2.1 um RGGB or RCCB pixels	
FOV (Deg)	30x17	85x48

Expected Max Working Distance (mm)	>50mm	~23mm

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What is Provided

- Hardware Quartus will provide:
  - Laser Module (including power cable and USB cable)
  - Illuminator Module (including power cable and USB cable)
  - Single mode fiber patch cable
- Hardware LGIT will need to provide:
  - DUT
  - DUT interface (nest or socket)
  - Framegrabber
  - Test fixture interface plate (to locate socket relative to Tesseract Illuminator)
  - Enclosure (optional, to mitigate stray light)

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Quartus Deployment Support

- Quartus does not have in-region support staff, expects all support to be remote
- Quartus to charge for support on a per hour basis at standard rates with a not-to-exceed limit
  - Estimate for total system deployment ~$20.4k USD in support

	TOTAL SUMMARY		Level 2 Project Management		Level 2 Opto-Mechanical Engineer		Level 3 Electrical Engineer	
		RATE:	$ 224.00		$ 163.00		$ 194.00	
	HOURS	PRICE	HOURS	PRICE	HOURS	PRICE	HOURS	PRICE
	106	$ 20,368.00	10	$ 2,240.00	16	$ 2,608.00	80	$ 15,520.00
(1) System Architecture	**20**	**$ 3,504.00**	**4**	**$ 896.00**	**16**	**$ 2,608.00**	**0**	
CAD Review	20	$ 3,504.00	4	$ 896.00	16	$ 2,608.00		
(2) Image Processing Support	**86**	**$ 16,864.00**	**6**	**$ 1,344.00**	**0**		**80**	**$ 15,520.00**
Algorithm Development and Deployment	86	$ 16,864.00	6	$ 1,344.00			80	$ 15,520.00

  - Total estimate (official quote to be released) = $42,647 USD
    - ($22,278 Hardware + $20,368 support)
    - Does not include optional IQC equipment

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Hardware Details

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Q5179-0160 Laser Module

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Q5179-0160 Laser Module

- Net weight: 8.9 kg
- 438 mm X 380 mm X 145 mm (L X W X H)
- Specs:
  - Supply 4 channels of light output
  - 532 nm (green) light
  - FC/APC fiber output
  - Requires AC voltage input (100-250 VAC, 50/60Hz)
    - 50W max power
  - USB port for software control and calibration storage
  - Interlock input for safety switch
  - Indicator LED
- Accessories Included:
  - Power cord
  - USB cord

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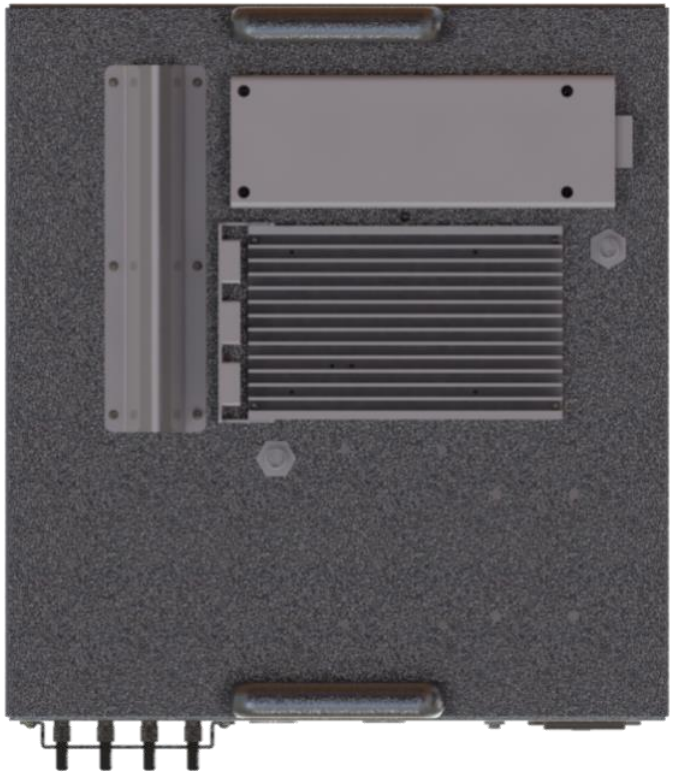
Q5179-0160 Laser Module

TOP



SIDE

FRONT

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Q5179-0160 Packaging

- Carton Size: 26x22x12 inches
  - (660 x 559 x 305 mm)
- Gross Weight: 12.7 kg

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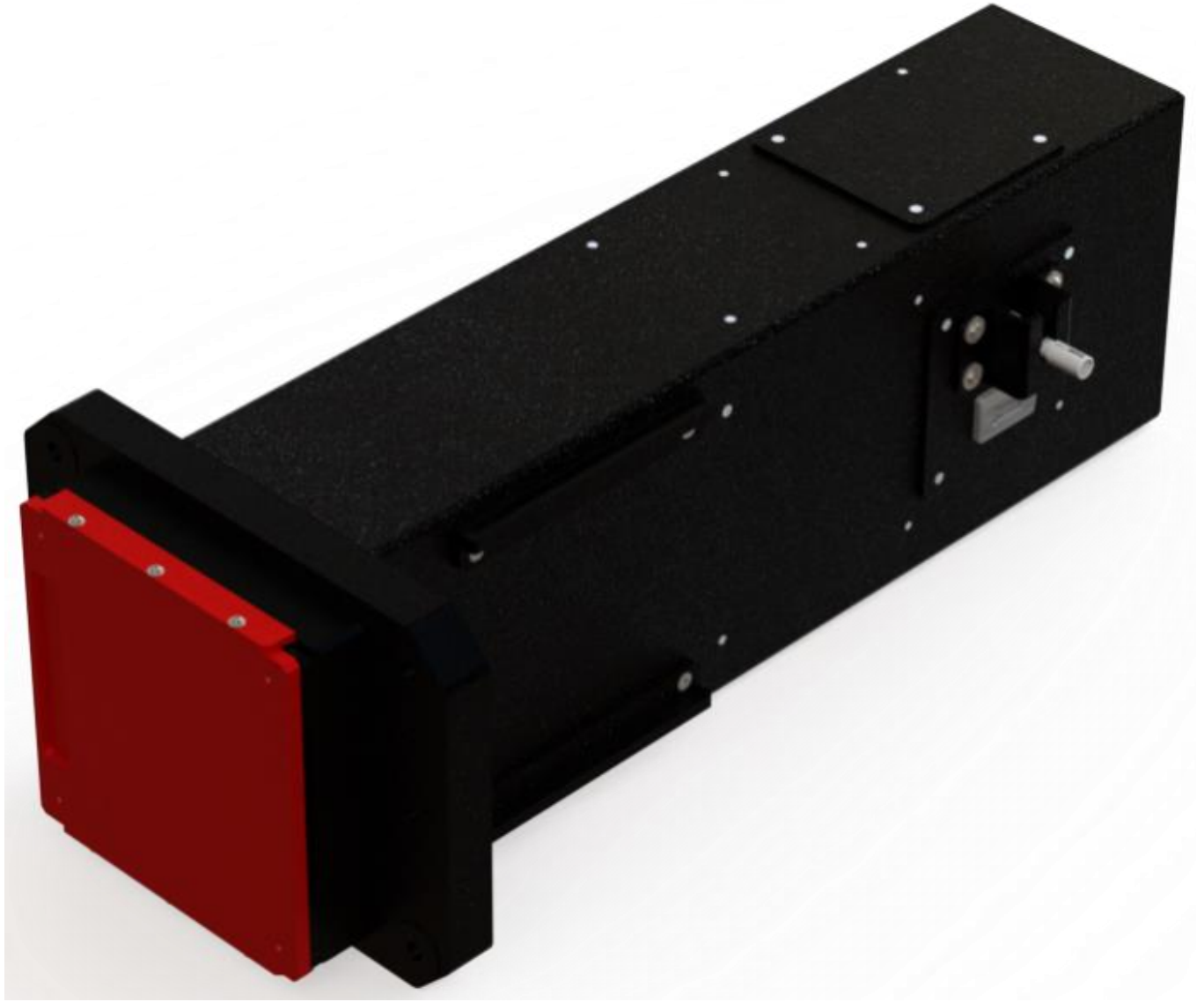
Q5179-0050 Tesseract XLHD Illuminator

Q5179-0050 Tesseract XLHD Illuminator

- 3.6 kg net weight
- 420 mm X 185 mm X 134 mm (L X W X H)
- Specs:
  - Optical test pattern generator for camera calibration
  - FC/APC fiber input
  - USB port for calibration storage
  - Remove shipping cap after installed in fixture
- Accessories Included:
  - FC/APC Fiber optic patch cable
  - USB-C cord



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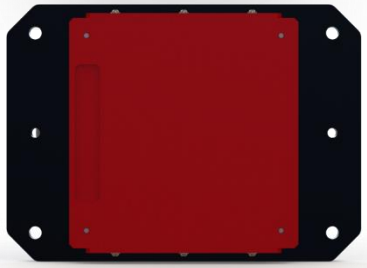
Q5179-0050 TESSERACT XLHD ILLUMINATOR

TOP

SIDE



FRONT

SIDE

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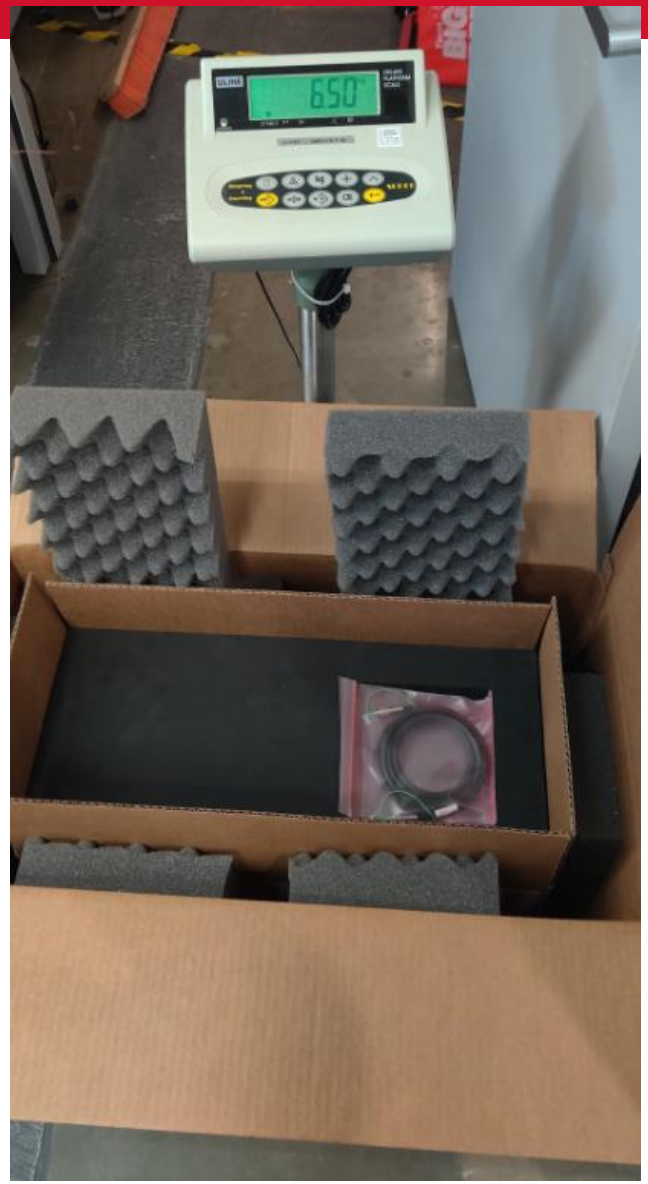
Q5179-0050 Packaging

- Carton Size: 26x14x14 inches
  - (660 x 356 x 356 mm)
- Gross Weight: 6.5 kg



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