Princeton Instruments

PI-MAX®4: 1024i-RF

The PI-MAX4: 1024i-RF from Princeton Instruments is the ultimate scientific, intensified CCD camera (ICCD) system, featuring a 1k x 1k interline CCD fiberoptically coupled to Gen III filmless intensifiers. These intensifiers provide the highest possible sensitivity in the visible and NIR wavelengths. The integrated RF modulation capability of 1 MHz - 200 MHz makes this fiberoptically-coupled ICCD camera ideal for RF modulation FLIM experiments. Princeton Instruments' integrated programmable timing generator, SuperSynchro, is built into the camera, making it the perfect choice for time-resolved imaging applications, while the special Dual Image Feature (DIF) allows two images to be captured in rapid succession, ideal for Particle Image Velocimetry (PIV) applications.

PI-MAX4: 1024i-RF is the only ICCD camera in the world that allows frequency domain and time domain imaging with megapixel resolution and 16 bit digitization.

FEATURES	BENEFITS
1024 x 1024 imaging array	High resolution imaging
32 MHz* / 16-bit digitization	Video frame rates and higher to efficiently synchronize with high repetition rate lasers
Thermoelectric cooling	Reduces CCD dark current to negligible levels
Gen III filmless intensifiers	Best sensitivity and gate speed in the desired wavelength range
Fiberoptic coupling	Highest optical throughput; No vignetting
RF Modulation	Built-in, fully software-programmable frequency, phase and amplitude options allow full control for intensifier gain modulated, high resolution imaging
Super HV - Built-in high voltage pulser	Rugged design without a bulky external controller, for high repetition rate gating and minimal insertion delay
SuperSynchro - Built-in programmable timing generator	Built-in, fully software-controlled gate timing; Controls gate widths and delays in linear, or exponential increments; Low insertion delay (< 27 ns). *See page 3 for more info.*
SyncMaster I and II	Provides continuous TTL signals to control external instruments such as a laser; Eliminates need for external timing generater in most experiments
Dual Image Feature (DIF)	Allows the rapid succession capture of two images with interframe time of < 500 ns
GigE interface	Industry standard for fast data transfer over long distances, up to 50 M
Optional: LightField® (for Windows 8/7, 64-bit) Or WinView/Spec (for Windows 8/7/XP, 32-bit)	Flexible software packages for data acquisition, display and analysis; LightField offers intuitive, cutting edge user interface, IntelliCal® and more.
PICAM (64-bit) / PVCAM (32-bit) software development kits (SDKs)	Compatible with Windows 8/7/XP, and Linux; Universal programming interfaces for easy custom programming.
LabVIEW Scientific Imaging Tool Kit (SITK®)	Pre-defined LabView vis provide easy integration of the camera into complex experiment setup

* With dual port readout at 16MHz/port
Detector shown with a C-mount nose and lens, sold separately

Applications:

Fluorescence Lifetime Imaging Microscopy (FLIM) | Time Resolved Imaging & Spectroscopy | Combustion

Planar Laser Induced Fluorescence (PLIF) | Particle Imaging Velocimetry (PIV)

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SPECIFICATIONS

CCD	
Image sensor	Kodak KAI-1003 scientific grade interline CCD
CCD format	1024 x 1024 imaging pixels; 12.8 x 12.8 µm pixels; 13.1 x 13.1 (18.5 mm diagonal)
System read noise (typical) @ 4 MHz digitization @ 16 MHz digitization @ 32 MHz digitization	 16 e- rms 40 e- rms 70 e- rms
Pixel full well	130 ke-
Dark current @ -25° C (typical)	< 2 e-/p/sec
CCD temperature @ + 23° C room temperature @ + 20° C ambient	 -20° C (Air), -30° C (Liquid assist), Guaranteed -25° C (Air), -35° C (Liquid assist)
Vertical shift rate	2.5 µs/row (variable via software)
DIF mode interframe time	450 ns (min); P46 phosphor decay time - 500ns (to 10%), 2 µsec (to 1%)
INTENSIFIER	
Intensifiers available	18 mm - Gen III filmless
Method of coupling to the CCD	1:1 fiber optic
Intensifier type	HBf and HRf
Wavelength range	See QE curve, pg. 5
Min. Gate Width (Optical FWHM) *	~ 2 ns (typical), 3 ns (guaranteed)
Repetition rate: Sustained	1 MHz
Resolution limit	57 to 64 lp/mm
Equivalent Background Illumination (EBI) Photo e-/pixel/sec @ room temp (with photocathode cooling)	 0.02 (0.002)
Phosphor	P43 and P46
Operating environment	+5° C to +30° C non-condensing
Storage environment	-25° C to +55° C
Certification	CE

* Measured with 18 mm intensifier. Contact your local sales representative for more information.
All specifications subject to change.

FRAME RATES

Binning	1024 x 1024	512 x 512	256 x 256
1 x 1	26	48	85
2 x 2	56	90	140
4 x 4	95	142	199

NOTE: Frames per second at 32MHz

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The PI-MAX4's integrated SuperSYNCHRO Timing Generator lets researchers set gate pulse widths and delays under GUI software control. The closed coupled SuperSYNCHRO significantly reduces the system delay inherent in the timing generator of *em*ICCD cameras. The integrated timing generator means there is no need for an additional external timing generator, and a built-in Super HV high voltage pulser eliminates the requirement for an external high-voltage supply, making the PI-MAX4 camera one of the most advanced ICCD cameras on the market.

FEATURE	BENEFITS
Closed Coupled Design	Short signal paths for minimum insertion delays
On-board memory	Store and execute complex gate width/delay sequences with no software overhead
Internal oscillator *	Drive an external event and initiate repetitive experiments.
SyncMASTER Pulses	Independent continuous TTL outputs to trigger pulsed external devices, e.g. laser and Q-switch; Minimum experiment jitter
Configurable Trigger inputs	Synchronizes camera to a wide variety of standard and non-standard trigger sources.
Full Software Control	Easy setup and execution of complex gate width/delay sequences

SuperSYNCHRO Specifications

Internal Timing Generator	0.05 Hz - 1 MHz
Gate Delay + Width Range*	~0.01 ns to 21 sec (from T0)
Timing resolution/ Timing jitter	10 ps / 35 ps rms
Insertion delay	< 27 ns (trigger in to intensifier opening)
TRIGGER INPUTS	
External Sync (Trigger In)	-5 v to +5 v (including TTL); AC/DC coupling: 50 ohm / High Z Variable Threshold; +ve or -ve edge
Pre Trigger In	TTL input. A rising edge will stop CCD Cleans and set camera to wait for the external trigger for fastest response. User selectable option.
TRIGGER OUTPUTS	
$SyncMASTER_1$	Programmable continuous frequency output to synchronize external devices with PI-MAX4, e.g. Laser
$SyncMASTER_2$	Programmable continuous frequency output (delay from $SyncMASTER_1$ - 100 ns - 6.55 msec) synchronize external devices with PI-MAX4, e.g. Q-switch
T0	TTL Signal: T0 indicates start of timing sequence
Monitor	TTL signal to monitor actual gate timing
Ready	TTL signal. Represents camera status. It changes state when ready just before the exposure.
Aux	DC coupled programmable delay (Delay from T0 - 0.01ns - 1 sec) trigger output to synchronize external devices with PI-MAX4
Logic	Software programmable: Select one of the following signals: Acquiring, Image Shift, Logic 1, Readout, Shutter or Wait for trigger. *See users' manual for detailed signal descriptions.*

* Software programmable

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The PI-MAX4: 1024i-RF lets the researcher perform frequency domain measurements of fluorescence lifetime study with a minimum of external equipment. By modulating the gain of the Gen III filmless intensifier at a Radio Frequency (RF) rate, the camera operates as a 2D lock-in amplifier. Each pixel acts as an individual phase sensitive (lock-in) detector. The PI-MAX4: 1024i-RF is used in advanced imaging techniques such as FLIM, FRET, etc..

The camera has two independent built-in direct digital synthesizers. One generates the RF to modulate the intensifier, while the other provides a user controlled RF signal that can be used to modulate the illumination to accomplish the RF phase sensitive detection. The RF amplifier which drives the intensifier is built into the camera. The LightField advanced GUI lets the researcher select frequency, control phase sweep range and granularity, and set the user RF output p-p voltage levels. The built-in RF modulator allows control over all the intensifier gain control parameters for ***precise*** measurements.

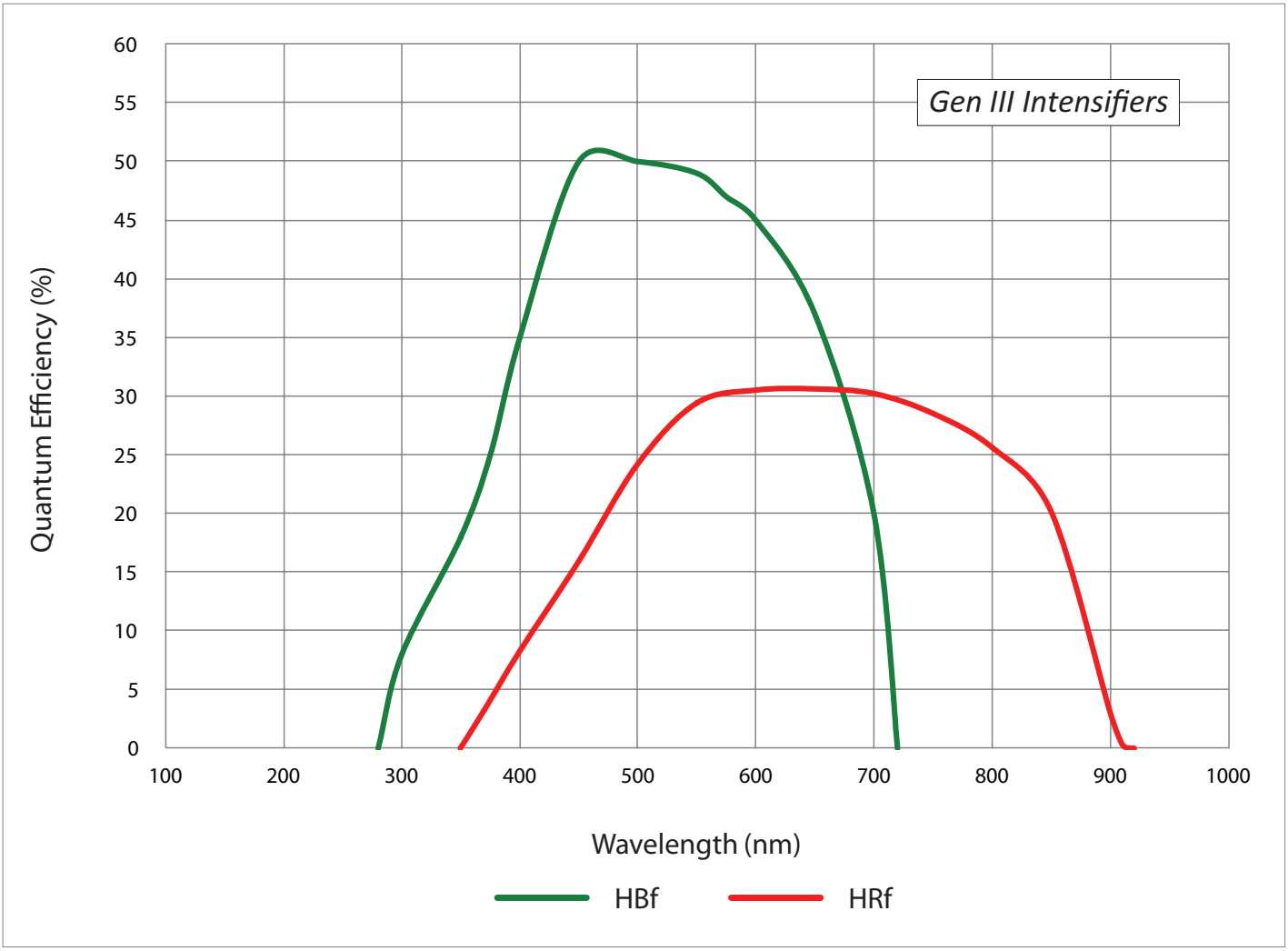
The integrated frequency generator means there is no need for an additional external expensive frequency generator, and a built-in Super-HV high voltage power supply / pulser eliminates the requirements for an external high-voltage supply, making the PI-MAX4: 1024i-RF camera one of the most advanced ICCD camera in the world.

FEATURE	BENEFITS
Closed coupled design	Short signal paths for minimum insertion delays
On-board memory	Store and execute complex gate width/delay sequences or RF sequences with no software overhead
Internal oscillator*	Drive an external event and initiate repetitive experiments
SyncMaster pulses	Independent continuous TTL outputs to trigger pulsed external devices, e.g. laser and Q-switch; Minimum experiment jitter
RF frequency output	Programmable continuous frequency output to excite external light modulator
Configurable trigger inputs	Synchronizes camera to a wide variety of standard and non-standard trigger sources
Full software control	Easy setup and execution of complex sequences

RF Modulator Specifications

Modulation Frequency	1 MHz - 200 MHz in 1 MHz increment
Phase Modulation	Static phase: 0° – 359° in 1° increments; Programmed sweeps (can cover > 360 degrees)
User RF Output voltage	0.1 – 1.6 Vp-p in 0.01 v increments
OUTPUTS	
User RF OUT	Programmable continuous frequency output to synchronize external devices with PI-MAX4
MON RF OUT	An approximate indicator of the RF applied to the photocathode.

* Software programmable



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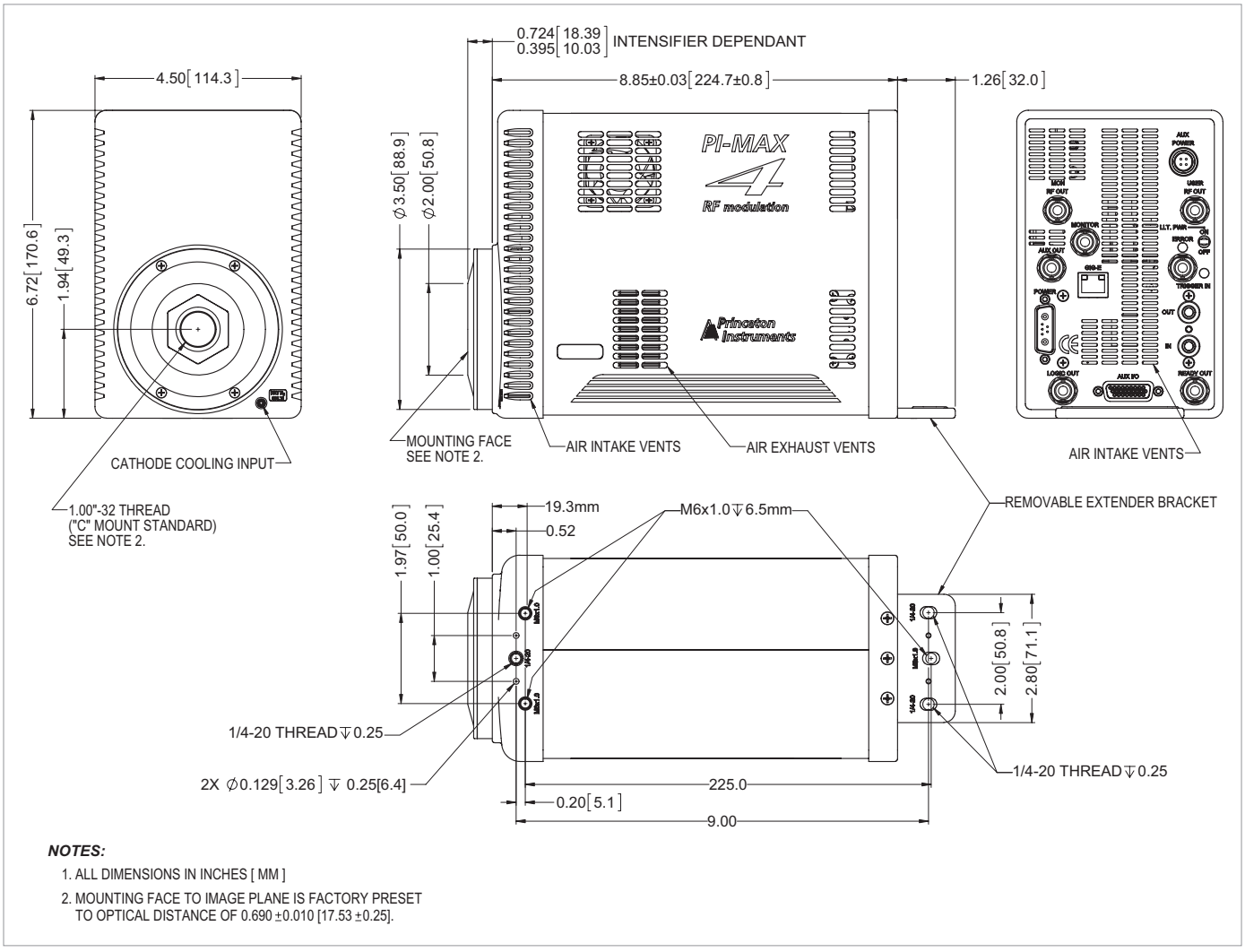
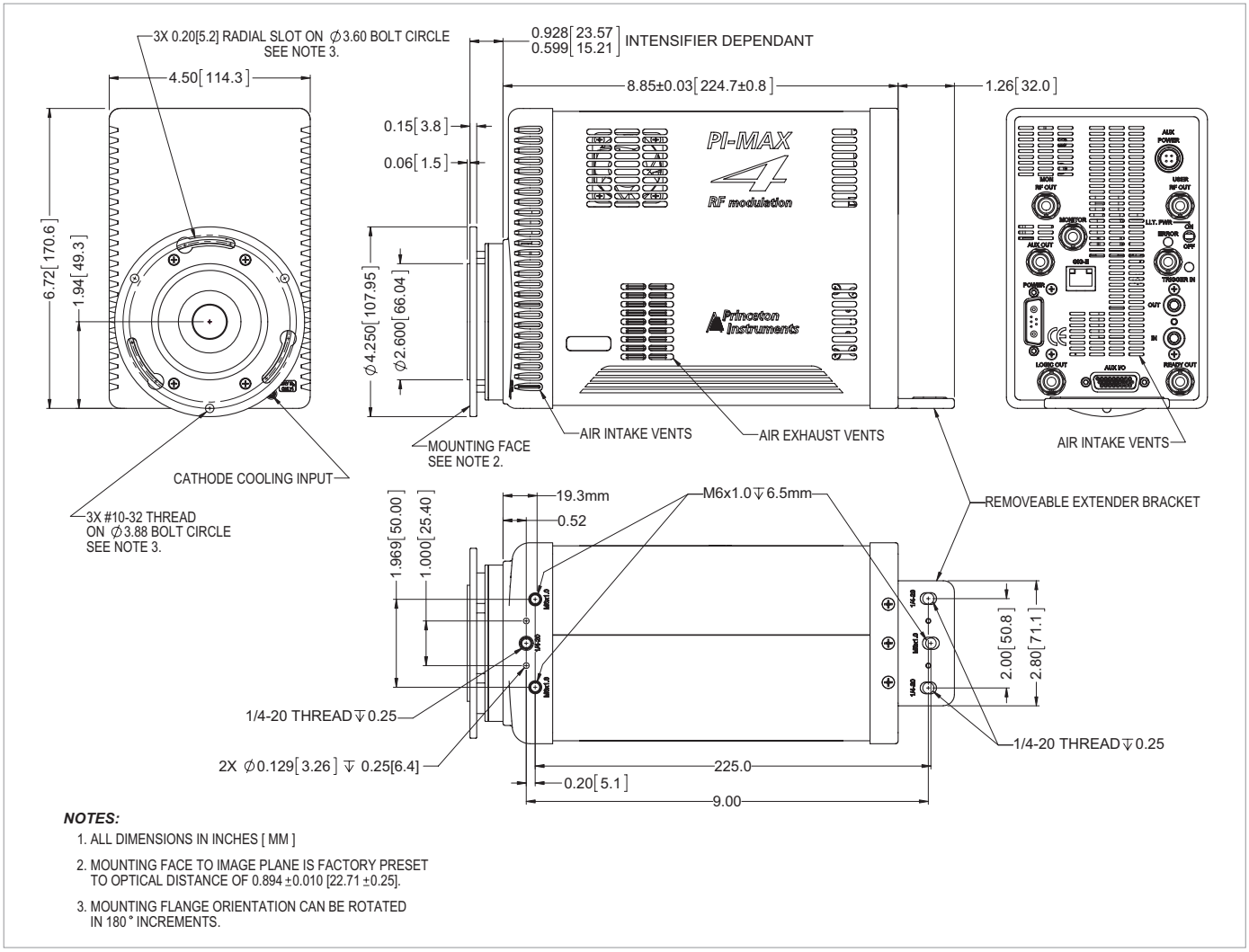
OUTLINE DRAWING
"C" MOUNT



NOTES:

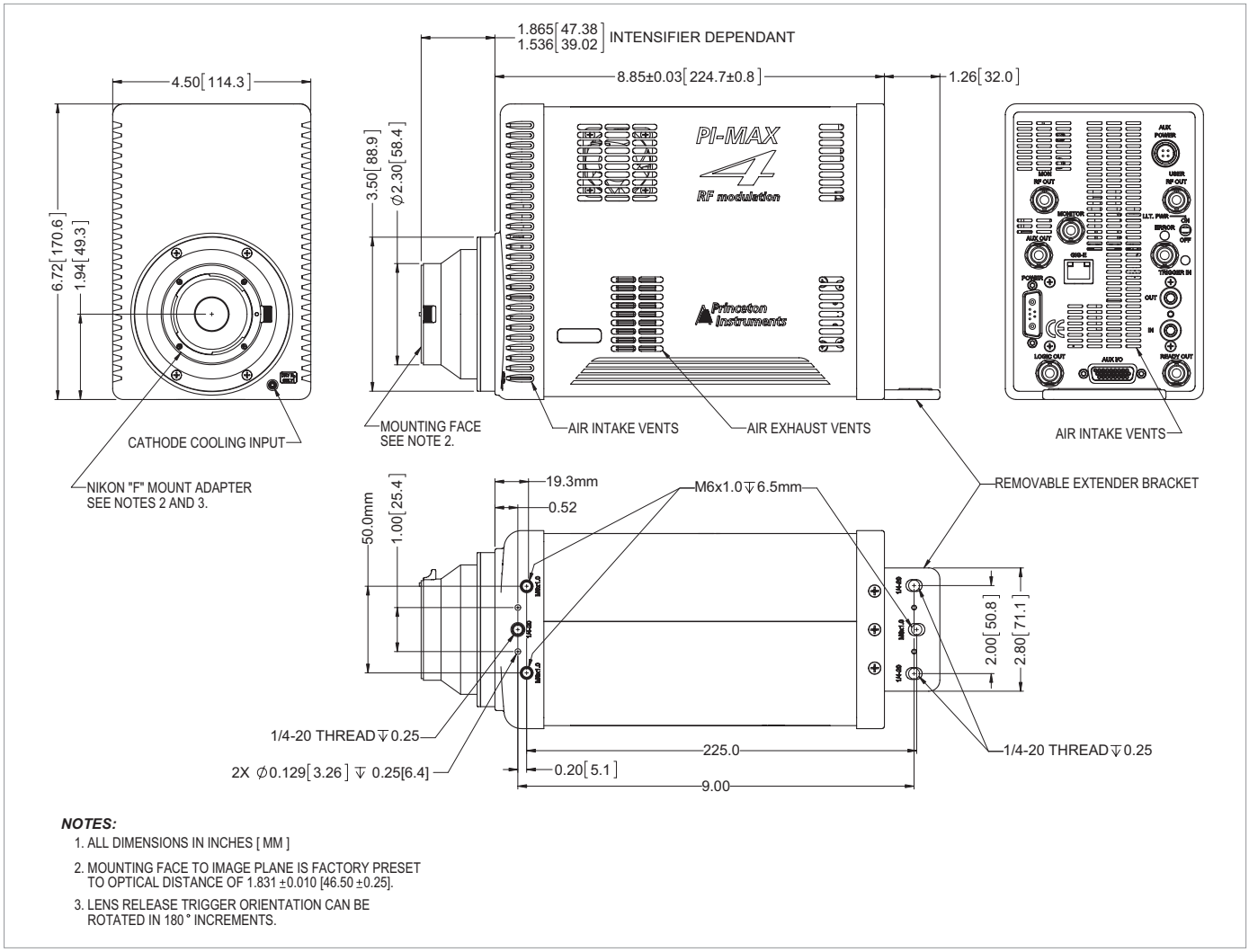
1. ALL DIMENSIONS IN INCHES [MM]
2. MOUNTING FACE TO IMAGE PLANE IS FACTORY PRESET TO OPTICAL DISTANCE OF 0.690 ±0.010 [17.53 ±0.25].



NOTES:

1. ALL DIMENSIONS IN INCHES [MM]
2. MOUNTING FACE TO IMAGE PLANE IS FACTORY PRESET TO OPTICAL DISTANCE OF 0.894 ±0.010 [22.71 ±0.25].
3. MOUNTING FLANGE ORIENTATION CAN BE ROTATED IN 180 ° INCREMENTS.

OUTLINE DRAWING
"F" MOUNT



NOTES:

1. ALL DIMENSIONS IN INCHES [MM]
2. MOUNTING FACE TO IMAGE PLANE IS FACTORY PRESET TO OPTICAL DISTANCE OF 1.831 ±0.010 [46.50 ±0.25].
3. LENS RELEASE TRIGGER ORIENTATION CAN BE ROTATED IN 180 ° INCREMENTS.

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