

3D at Depth
Wide Swath LiDAR
Factory Acceptance Test
Revision: 2.1
March 2025

1. Purpose:

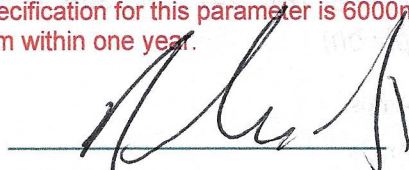
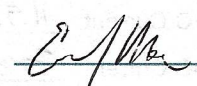
The purpose of this document is to capture all the Factory Acceptance Tests to be performed at 3D at Depth's Longmont site with MBARI personnel. A hard copy of this document with MBARI and 3D at Depth representative sign-offs will be delivered with the system.

2. Mechanical

2.1. Depth Certification of Housing

To date, the housing was certified to a depth of 4,000 MSW and pressured tested to 20% over working depth, 4810 MSW (7000 PSI). See Appendix 1 for details of pressure test.

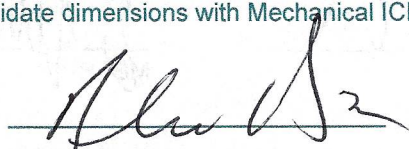
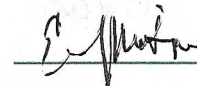
The specification for this parameter is 6000m which has not been met; 3D at Depth will retest to 6000m within one year. NS


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2.2. Mounting Calibration Report

Mounts are rigid and will hold calibration.

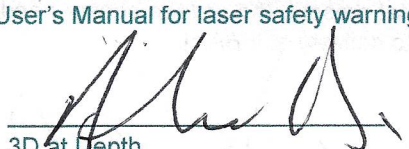
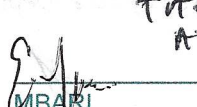
Validate dimensions with Mechanical ICD. (Mike S.) to review M.E.


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2.3. Tooling, tools, and support equipment (Mike S.)

Provide a list of all tooling, tools and support equipment that would be used to service the system.

- See Mechanical ICD for hardware / fastener requirements for interfacing to the mount plate
- See User's Manual for laser safety warnings.


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(W IT IT DELIVERY
TANK TEST)
AT MBARI NS

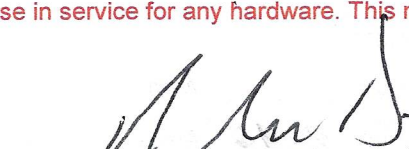
The following items will be included with the system:

Qty (5) spare anodes P/N M000249 will be provided with the deliverable. _____

Qty (1) set spare Optical Head Safety Cover screws will be provided with the deliverable. _____

Qty (1) Optical Head Safety Cover will be provided with the deliverable. _____

The Head safety cover is not complete, missing holes for mounting screws. There are two types of anodes used in this design, and we request 5 spares of each. Please dictate which grease to use in service for any hardware. This must be addressed prior to delivery at MBARI.


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3. Electrical and Thermal:

24V measurements will be performed with MBARI provided 140W power supply: model VMS-225C-24-CNF. 18V and 36V measurements will be performed with a standard lab power supply.

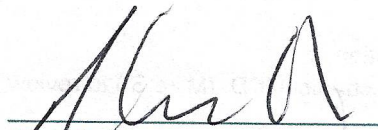
- 3.1. Measure DC in-rush current draw at 18V, 24V, and 36V: *(Kevin: on secondary from established 24 volts supply on)*

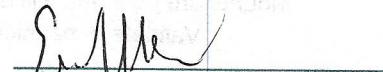
18 VDC: DC Current: 11.52 Amps

24 VDC: DC Current: 7.6 Amps

36 VDC: DC Current: 6.4 Amps

Images (from Kevin) at 24 Volts in Appendix 2:


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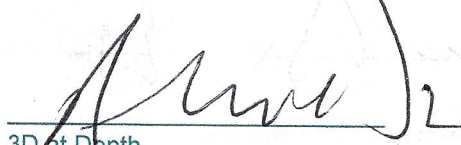
- 3.2. Measure DC current draw at 18V, 24V, 36V **while scanning**:

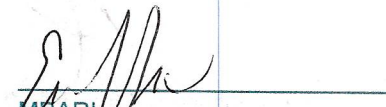
18 VDC: DC Current: 5.32 Amps

24 VDC: DC Current: ~~13.12~~ 2.46 Amps

36 VDC: DC Current: ~~13.12~~ Amps

- W* The system cannot scan at 36VDC at present, the voltage sensor needs calibration. This will be addressed by 3D at Depth prior to delivery at MBARI.


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- 3.3. Measure DC current draw at 18V, 24V, 36V while at **steady state**:

18 VDC: DC Current: 3.18 Amps

24 VDC: DC Current: ~~2.46~~ 2.5 Amps

36 VDC: DC Current: 1.962 Amps

Low-Power State (18 VDC): DC Current: _____ Amps

Low Power State (24 VDC): DC Current: 2.46 Amps

Low Power State (36 VDC): DC Current: _____ Amps

- W* Low power state is not complete or testable, 3D at Depth will complete this feature within one year of the FAT date.

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- 3.4. Let the system soak in 3°C salt water (~32 PSU) for approximately 1 hour to reach thermal stability. Then power on system and perform scans to demonstrate normal operation. **(in aquarium with cover look at RTV)**

The system cannot scan in normal operation when the laser temperature is below normal operating temperature (~12C). 3D at Depth will resolve this issue within 1 year of FAT.

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(trissor was not present, automation is restored)

- 3.5. Measure time that system can operate out of water in idle condition after Test 3.4 before reaching temperature limits (no more than one hour):

> 1 hour

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- 3.6. Demonstrate long term operation of the sensor at full power in scanning operation in < 20°C Water.

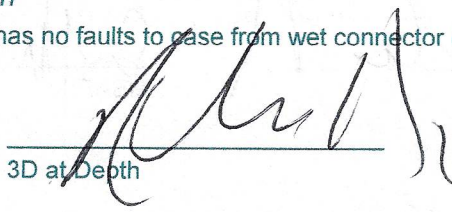
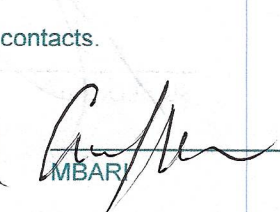
The system was seen to overheat when the laser module temperature exceeded 40C during day 2 of FAT. Alarm limits may be increased after consultation with the laser vendor. 3D at Depth will resolve this issue before delivery to MBARI.

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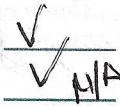
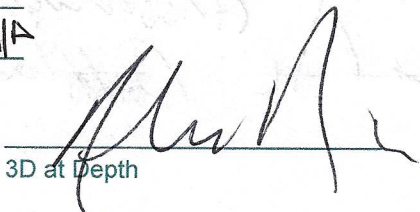
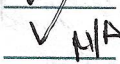
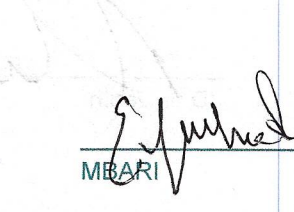
3.7. *Pin Isolation*

Test system has no faults to case from wet connector contacts.


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MBARI3.8. *Demonstrate successful isolation of 1PPS/ZDA input.*

ZDA input is via Ethernet, therefore is isolated by design.

PPS & PPS ground pins will be validated against housing and all other connector pins.

PPS: ZDA: 
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4. Software:

- 4.1. Demonstrate successful real time target data collection at maximum acquisition rates.

Show profile and waterfall graphs while moving objects during scan: ☒

Show presence of archived data: ☒

Process data for 3D Cloud visualization: ☒

Show scan rates: ☒

In profile visualization, 0 as vertical down, with positive angles to starboard, and ordering angles in a scan from -180 to +180. System cannot collect data continuously at the maximum frequency of the laser pulse. Laser optical output power is below desired levels. A sample data file code sample will be developed. 3D at Depth will resolve this within 1 year of the FAT date.

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- 4.2. Demonstrate CTD input, PPS/ZDA input functions properly

PPS/ZDA demonstrated with in-house GPS, 3D at Depth test software, and visual inspection of sensor clock synchronized: ☒

Demonstrate CTD auto-update across Ethernet with 3D at Depth test SW. Visual inspection of sensor GUI to show updates: ☒

Visual inspection of status LEDs on GUI: ☒

Instability in the PPS indicators in the GUI exist. When testing on in-house GPS, the 3v3 level of the PPS did not successfully trigger the input on the sensor. CTD messages have been received successfully, but log files are being broken too often, overwrite the same file per day. CTD Socket on the sensor times out and closes the connection at rates ~1Hz. Clarify CTD Indicator behaviour on the GUI. 3D at Depth will change this prior to delivery at MBARI.

Ensure Function on 3V3 → 5V

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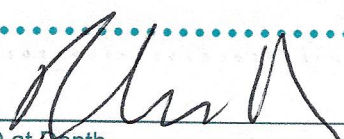
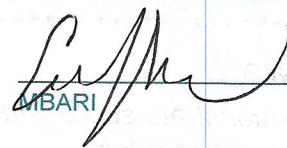
- 4.3. Demonstrate that topside software can be installed on new topside machine (in case of field failure of acquisition machine)-**install in Eric's Laptop**

Documentation of how to perform this will be provided prior to delivery at MBARI.

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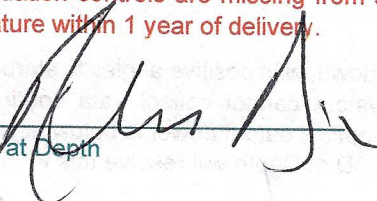
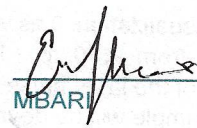
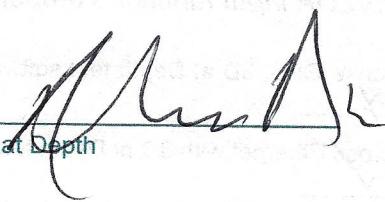
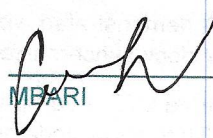
- 4.4. Demonstrate system functionality through Ethernet
Validate **100 Mbps** communications through cable


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MBARI4.5. *Demonstrate remote control protocol*

Turn off, on, low power state, turn off laser, turn on laser

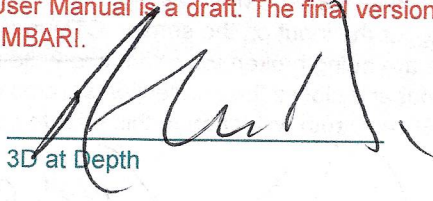
Demonstrate the ability to save and run a script from the sensor

Power and attenuation controls are missing from scripts and CCI interface. 3D at Depth will complete this feature within 1 year of delivery.


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MBARI4.6. *Step through all GUI Command operations (3D Collect), functions, configurations and safety features*Temperature sensing on Red1 is not working. 3D at Depth will complete this feature within 1 year of delivery. *or change for*
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MBARI4.7. *Ensure the Help button in 3D Collect opens the User Manual*

The current User Manual is a draft. The final version will be available, pending approval, prior to delivery at MBARI.

DUE AT DELIVERY


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MBARI4.8. *Step through all GUI visualization operations (Real Time Viewer), functions, and configurations*

Orientation of the polar plot needs to be adjusted, this will be complete before delivery to MBARI

See 4.1

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4.9. Step through Tool Operations (2D Viewer, 3D Cloud Motion, etc.)

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5. Performance:

5.1. Qualify swath width of final assembly

Swath should be 360° (minus the upper area covered to reduce scan file size).

Measure distance to wall and measure scan width on wall. Compare to trig calculation.

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5.2. Demonstrate outputs from two red channels

This specification is currently not complete or testable, 3D at Depth will complete this feature within one year of the FAT date

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5.3. Demonstrate output from accelerometer

This specification is currently not complete or testable, 3D at Depth will complete this feature within one year of the FAT date

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5.4. Demonstrate system safety features

Safety light on during scan: ☒

Verify emergency stop button in GUI shuts off laser: ☒

Verify loss of ethernet laser safety: (if no communication laser will shut off within a specified amount of time) ☐

Validate 3DC GUI is password protected: ☒

Loss of ethernet does not succeed at this time, leaving laser on with no recovery mechanism. Laser Emission indicator needs to accurately reflect the class rating of the laser. 3D at Depth will complete this feature prior to delivery at MBARI.

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5.5. Range Performance

System must achieve required range performance and precision.

Range 1-10m: ☒ ← IMPROVE from 8 current

Precision 3mm: ☒ NOT WITNESSED

FACTORY ACCEPTANCE TEST



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6. Shipping Manifest:

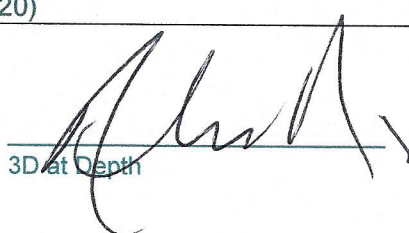
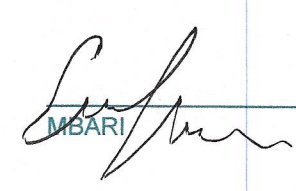
Optics Pelican Case

ITEM	Quantity
Wide Swath Dual Optical Head Assembly	1

Support Pelican Case

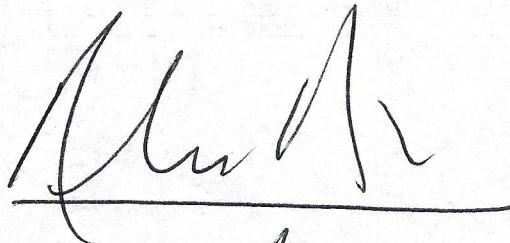
ITEM	Quantity
MacArtney 13-pin cable 3m (right angle)	1
13-pin MacArtney dummy plug, female	1
Black Locking Sleeve, Female (w/ Retaining Ring in Middle Groove)	1
Laser Safety Documentation	1
Spare handle screws & washers (4/ea)	4
Laser Safety Cover	1
Set of spare safety cover screws	1
Spare anodes (1/4-20)	5

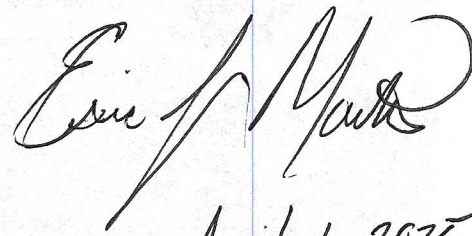
DEFER TO
DELIVERY


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7. Terms of Acceptance

In process of completing this set of Factory Acceptance Tests, items marked in red above represent incomplete features or issues within the sensor that prevent testing as prescribed. For each of these identified items, 3D at Depth agrees to address them in the dictated amount of time under the existing contract. It is acknowledged by both 3D at Depth and MBARI that the sensor is conditionally accepted under these terms, in order to allow for continued testing at MBARI's test facilities. Failure to resolve the identified items will be considered a violation of the contract.


April 1, 2025


April 1, 2025

Appendix 1: Pressure Test Results

3DatDepth MBARI Pressure Test - Output Cap 1/30/2025 Beatriz Santos, Kevin Hammond, Nick Thrasher
4000m working depth Test 20% over = 4810m = 7000psi

Rev A
Jan 2025

Cycle	Load Unload (Minutes)	Start Pressure (PSI)	End Pressure (PSI)	Rate (PSI/Minute)	Hold (Minutes)	Total Time (Minutes)	Notes	Tech Initial
2:40		0	7,000	500		14.0	ramp to 7000 psi	
2:54	10:45:00 AM	7,000	7,000		10	10.00	10 minute hold @ 7000 psi 7600	
3:04	10:55:00 AM	7,000	0	500		10.00	release to 0 psi	
3:11	11:05:00 AM	0	0		2	2.00	2 minute hold @ 0 psi	
3:35	11:07:00 AM	0	7,000	500		9.00	ramp to 7000psi	
3:45	11:16:00 AM	7,000	7,000		10	10.00	10 minute hold @ 7000 psi 7100	
3:55	11:26:00 AM	7,000	0	500		10.00	release to 0 psi	
4:06	11:36:00 AM	0	0		2	2.00	2 minute hold @ 0 psi	
4:06	11:38:00 AM	0	7,000	500		6.00	ramp to 6285psi	
5:06	11:44:00 AM	7,000	7,000		60	60.00	60 minute hold @ 7000 psi 7100	
5:06	12:44:00 PM	7,000	0	500	0	10.00	release to 0 psi	
5:06	12:54:00 PM	0	0	0	2	2.00	2 minute hold @ 0 psi	
	12:56:00 PM							
	3:21:00 PM							
Total Test Time (min)						145.0		
Total Test Time (hrs)						2.4		

Post Test Inspection

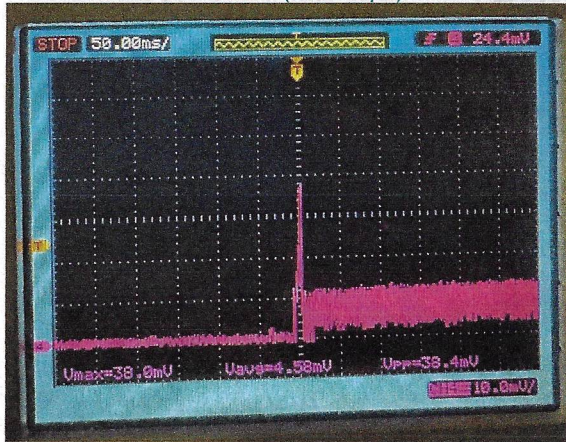
☒ Pass ☐ Fail

Date: 1/31/25

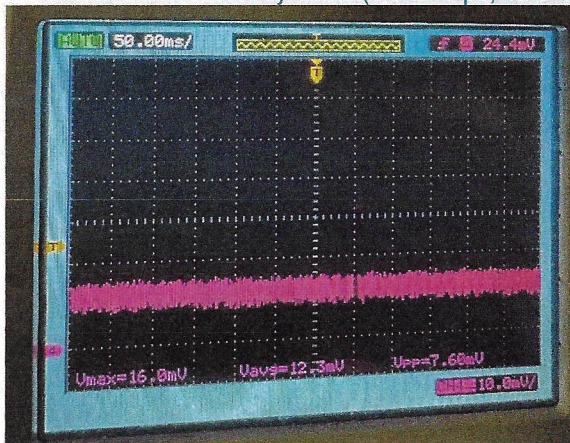
Appendix 2 – Current Testing Pictures

Scale: 10mv equates to 2 Amps ($V \times 0.2 = \text{Amps}$)

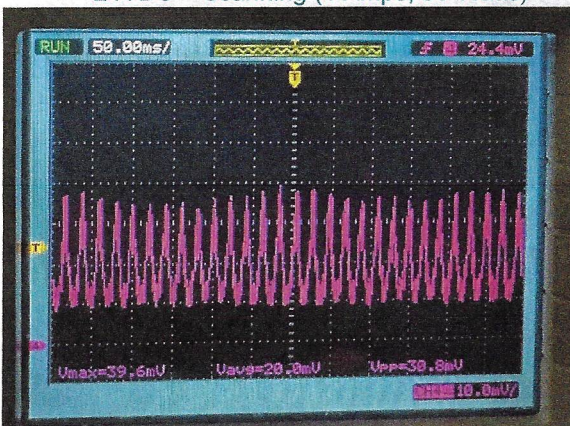
24VDC – Inrush (7.6 Amps)



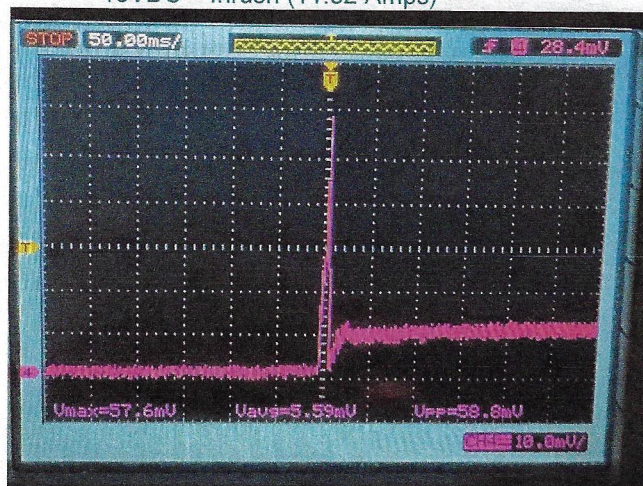
24 VDC – Steady State (2.46 Amps, 59.04 Watts)



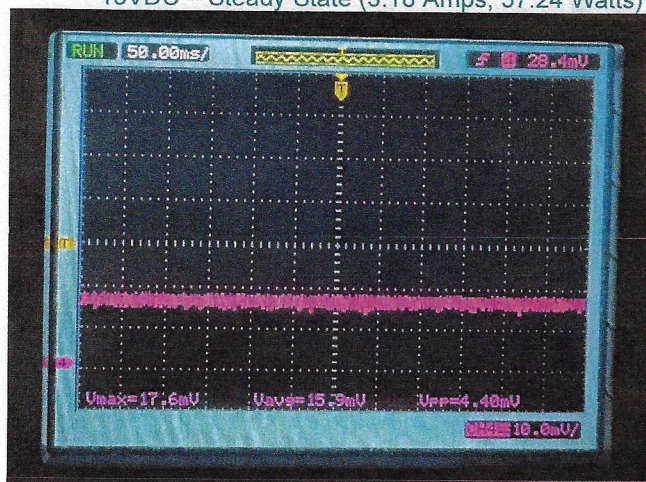
24VDC – Scanning (4 Amps, 96 Watts)



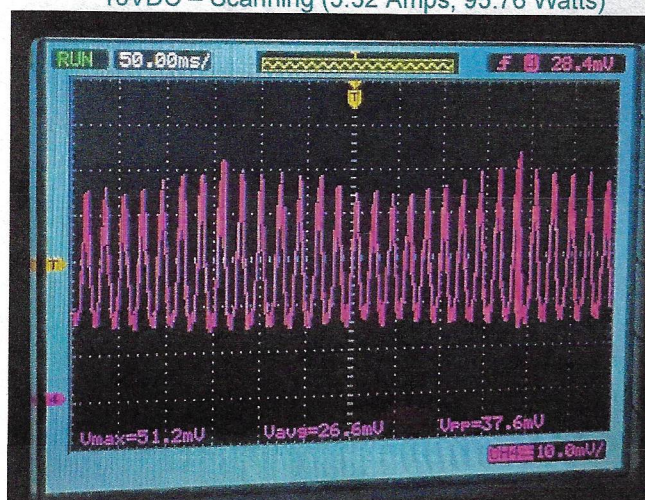
18VDC – Inrush (11.52 Amps)



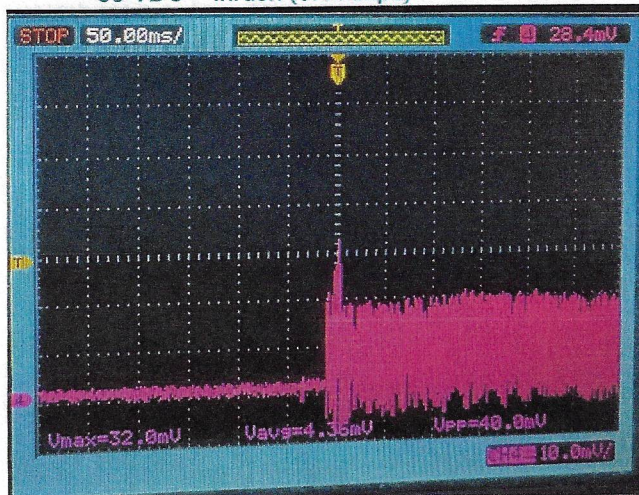
18VDC – Steady State (3.18 Amps, 57.24 Watts)



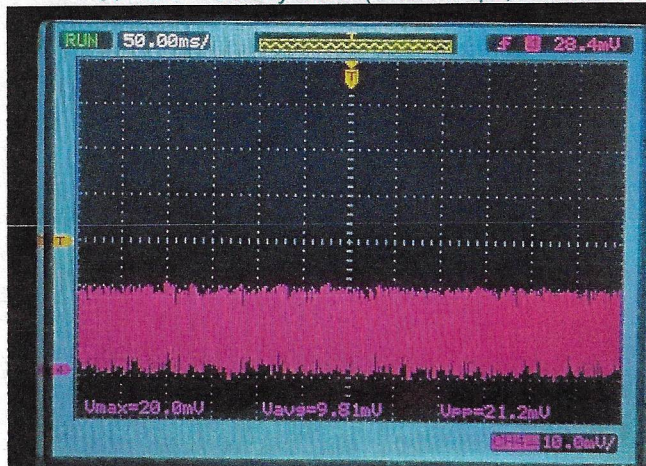
18VDC – Scanning (5.32 Amps, 95.76 Watts)



36 VDC – Inrush (6.4 Amps)



36 VDC – Steady State (1.962 Amps, 70.632 Watts)



36 VDC – Scanning

Not Measured