

| Rev. | ECO | Description | Checked | Approval | Date |
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| A | 85-099 | CDR Release | | | |
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VOILA Hardware
Interface Control Document

Dwg. No. 85-02010

Revision A
April 27, 2004



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Preface

This document describes the interface characteristics of the MIT VOILA experiment unique equipment (EUE) and any hardware that is “external” to the EUE, such as the JSC-provided HRF workstation, HRF rack, *etc.* There is a separate Software ICD document.

Section 1 is taken directly from the Hardware Requirements Document and is provided for background information only. It has not yet been updated to reflect the current nomenclature (see Section 2).

Revision A is issued as a baseline for the VOILA Critical Design Review.

1 General Description

1.1 *Experiment Overview*

VOILA will extend, simplify, and merge two sensory motor and performance experiments originally developed for the 1998 STS-90 Neurolab mission. The two components retain separate numbers (E085/E507) on ISS, but are performed together. The experiments use the HRF Workstation 2 as “science kiosk” to perform short (typically 30 minute long) tests to study the role of visual, vestibular, and haptic cues on spatial orientation and motor behavior. The experiment utilizes virtual environment generation accessories first developed for the Neurolab as a tool to study these processes during and after long duration (3-6 month) orbital flight. Restrained and free-floating subjects wear a wide field of view, color stereo head mounted display. Protocols are based on 1-G paradigms, require little set-up time, and can be selected and performed by an astronaut in an automated fashion using Session Manager software. Pre-flight, in-flight, and post-flight performances of each protocol are planned on each ISS increment.

The Specific Objectives are to determine the effects of microgravity on:

- The influence of scene symmetry, rotation, haptic cues, and expected orientation on static and dynamic self tilt (Virtual Tilting and Tumbling Room Protocols);
- the onset of x-axis illusory linear self-motion without haptic cues (Linear Vection Protocol);
- the effect of perceived orientation on visual object recognition and shape recognition (Object Recognition Protocols);
- whether information used in grasping remembered objects is stored in head fixed, body fixed, or exocentric reference frames (Virtual Grasping Protocol); and
- how the timing of catching movements depends on anticipation of downward acceleration (Virtual Catching Protocol).

The general hypothesis is that mental processes involved in self-orientation, object perception and motor control will be fundamentally altered in microgravity environments, as evidenced by visual reorientation, inversion, and proprioceptive illusions frequently reported in-orbit by astronauts. These experiments on self-orientation, linear vection, object perception and motor control will help to characterize the contribution of gravity to the mechanisms underlying these activities.

1.2 *Operational Overview*

In each session, based on the amount of crew time available, the Session Manager program suggests one or more of 5 different visual perception protocols and one or more of 4 different visuomotor tasks. In-flight protocols are performed in up to 3

possible conditions: quasi-free floating, lightly restrained, and/or with constant-force springs (simulated gravity).

Visual Perception

- Protocol 1: Tilted Room. Subject indicates perceived vertical while viewing a series of tilted scenes.
- Protocol 2: Tumbling Room. Subject indicatesvection magnitude and surface identity while viewing rotating scenes.
- Protocol 3: Linear Vection. Subject indicatesvection onset and magnitude while viewing a moving corridor scene.
- Protocol 4: Figures. Subject indicates which complex 2D figure seems most familiar.
- Protocol 5: Shading. Subject indicates which shaded circle seems most convex.

Visuomotor Coordination

- Protocol 6: Grasping. Upright. Subjects align the hand with an object oriented in 3D space.
- Protocol 7: Grasping. Head Tilt. Subjects repeat Protocol 6 with 30° head tilt.
- Protocol 8: Pointing. Subjects perform rapid point-to-point movements with the dominant hand.
- Protocol 9: Interception. Subjects intercept a flying ball with the dominant hand.

The following protocols will only be performed pre-flight and post-flight:

- Protocol 10: Tilted Bed. Subject aligns the bed to their subjective horizontal in a dark room.
- Protocol 11: Luminous Line. Subjects align a luminous line to their subjective vertical meridian in a dark room.
- Protocol 12: Tilted grasping. Subjects perform Protocol 6 while seated in a chair inclined by 30° in the frontal plane.

1.3 Hardware Overview

The VOILA experiment depicted in Figure 1-1 will utilize the Human Research Facility Workstation 2 (WS2), which is a rack-mounted computer drawer located in HRF Rack 1 and Rack 2. The VOILA experiment will use the following components of the WS2:

- The graphics accelerator cards in the WS2 are used to render virtual environments on the Head Mounted Display for the experiment protocols.
- The WS2 sound card is used to record the subject's audio notes.
- The WS2 data acquisition card is used to capture acceleration data from the Paddle for the Interception protocol.
- The USB ports of the WS2 are used to operate the head and body tracking system, the SID, and the Video Surveillance Camera.
- The VOILA software will reside and operate on the WS2 hard drive.

The VOILA experiment also utilizes the HRF Flat Screen Display and the Workstation Keyboard to operate the VOILA Session Manager software and the HRF Common Software on the WS2.

VOILA uses the 4 PU VIPER Drawer to interface its peripherals to the HRF WS2. The PI-provided electronics are housed in a NASA-provided chassis. The electrical components include power converters, head and body tracker control boxes, USB-to-serial converter, and USB hub. The 4PU VIPER Drawer will be located in HRF Rack 1 or Rack 2, near the WS2. It receives 28 VDC power from the HRF rack, and is cooled by the HRF common fan.

The head and body tracker system is built from COTS components. It consists of two major systems: (1) an inertial tracking system based on the Intersense IS300 Pro tracking system and (2) an optical tracking system based on the Charnwood Dynamics CODA camera system. The inertial tracking system uses 1-4 inertial cubes containing linear accelerometers and angular rate sensors to detect orientation and position information. Inertial cubes are mounted on the HMD, on the Paddle, and in the Chest Pack. The optical tracking system provides a second source of position and orientation information by tracking a set of infrared LED markers with cameras. The infrared LED markers are mounted on the HMD, the Paddle, and the Chest Pack. Three cameras are mounted into each Optical Tracker Camera Bar, and two bars are used to track all of the sensors. The Optical Tracker Camera Bars are mounted into the seat track at opposite ends of the module such that the subject wearing the infrared LED markers is in between them. The information from the inertial and the optical systems are combined, resulting in an accurate determination of the objects' position and orientation in space. The VIPER Drawer contains the CODA "Hub", which controls the cameras and infrared LED markers, and Intersense control box, which integrates the information.

The Subject Restraint System (SRS) is composed of four parts which are used to restrain the subjects in certain postures, prevent them from drifting into other equipment, and provide haptic feedback for certain protocols. The four parts of the Subject Restraint System are the SRS Vest, the SRS Platform, the SRS Spring Reel Assemblies, and the SRS Quasi-free Float Attachment.

The SRS Vest is an adjustable vest worn by the subject. The vest has attachment points for the SRS Spring Reel Assemblies along its waist, and for the SRS Quasi-free Float Attachment on the front and back of the Vest near the wearer's center of gravity. A number of adjustment straps on the Vest allow the subject to distribute the force from the SRS spring coils onto the waist and shoulders. The Vest has an attachment point for the Chest Pack, and attachment points for temporary stowage of the SID, the Hand Switch, and the Paddle. The Vest has an attachment point for a Torso Marker Plate, which is a metal plate with infrared LED sensors attached to track the subject's upper torso.

The SRS Platform is an adjustable aluminum platform that mounts onto the seat tracks. A set of infrared LED markers is mounted on the Platform to provide a stationary reference frame for the optical tracking system. Subjects will stand on the SRS Platform when using the SRS Spring Reel Assemblies to simulate gravity in the Room andvection protocols. It can be folded into a chair for the seated position, and unfolded into a bed for the supine position during the Grasping and Interception protocols. It has removable padding for comfort and wide Velcro straps for restraint.

The SRS Spring Reel Assemblies are two constant force springs that provide 30-40 lbs each of downward force to simulate the haptic sensations of gravity on the subject's feet. One end of each spring is mounted into a slot on the SRS platform. The other end of each spring is attached to the bottom of the SRS Vest. The Spring Reel Assemblies were originally designed and used for the Neurolab E136 experiments.

The SRS Quasi-free Float Attachment is a pole, approximately 1 meter in length, which has an attachment point on one end that fits into a seat track. The other end has a swivel joint and a quick-release attachment point for the SRS vest. The swivel joint allows the subject to drift rotationally somewhat while "free-floating" but prevents them from drifting into other equipment or out of the head/body tracker's working volume. The joint can also be locked to prevent large rotational motion.

The Chest Pack Interconnect Box is a connection box that is worn on the front of the SRS Vest. It has connections for devices that are used by the subject or mounted on the SRS Vest. It connects with the VIPER Drawer through one cable that provides power and data channels. The SID, paddle, HMD microphone, and a set of infrared LED markers on the SRS vest will connect into the Chest Pack Interconnect Box. The Chest Pack Interconnect Box will contain an inertial cube and have infrared LED markers mounted on its exterior.

The Head Mounted Display (HMD) is worn on the subject's head and provides a stereoscopic display to the wearer. It is a modified Kaiser ProView80 LCD-based stereoscopic display with a large field of view (64 degrees horizontal x 48 degrees vertical). The HMDs used in the Neurolab E136 experiments are upgraded with

lower power LCD displays, higher contrast units, and stronger space flight quality plastic frames. One inertial cube and several infrared LED markers will be mounted on the outer casing of the HMD. The HMD will connect to the front panel of the VIPER Drawer with two cables.

The Subject Microphone is a modified COTS computer microphone, used for subject voice recording. The Subject Microphone will be mounted to the HMD or the SRS Vest for hands-free operation.

The Headphones are modified COTS noise cancellation headphones. They will be worn with the HMD to suppress audio directionality cues.

The Subject Input Device (SID) is a modified COTS gamepad with two joysticks and several buttons. The SID will connect to the Chest Pack Interconnect Box. It will have an attachment point on the SRS Vest for temporary stowage. Subjects will respond to stimuli presented in the Room,vection, Figures, and Shading protocols using the SID.

The Paddle is a custom-made interface device, consisting of a handle that can be gripped with either hand. In the dominant hand, the Paddle is used to measure hand movement, position and orientation during the Grasping and Interception protocols. The Paddle contains one inertial cube and a linear accelerometer to detect motion onsets. A set of infrared LED markers is mounted on the exterior. The Paddle is connected to the Chest Pack Interconnect Box through a single Y-cable that it shares with the Hand Switch.

The Hand Switch is a modified COTS device with a single button that can be operated with either hand. During the Grasping and Interception protocols, it is held in the hand opposite the Paddle, and the button is pressed to trigger the beginning of a trial. The Hand Switch is connected to the Chest Pack Interconnect Box through a single Y-cable that it shares with the Paddle.

The Subject Surveillance Camera is a modified COTS device used to capture still images of the subject performing the experiment. It will be mounted to the wall or ceiling of the module with a seat track attachment.

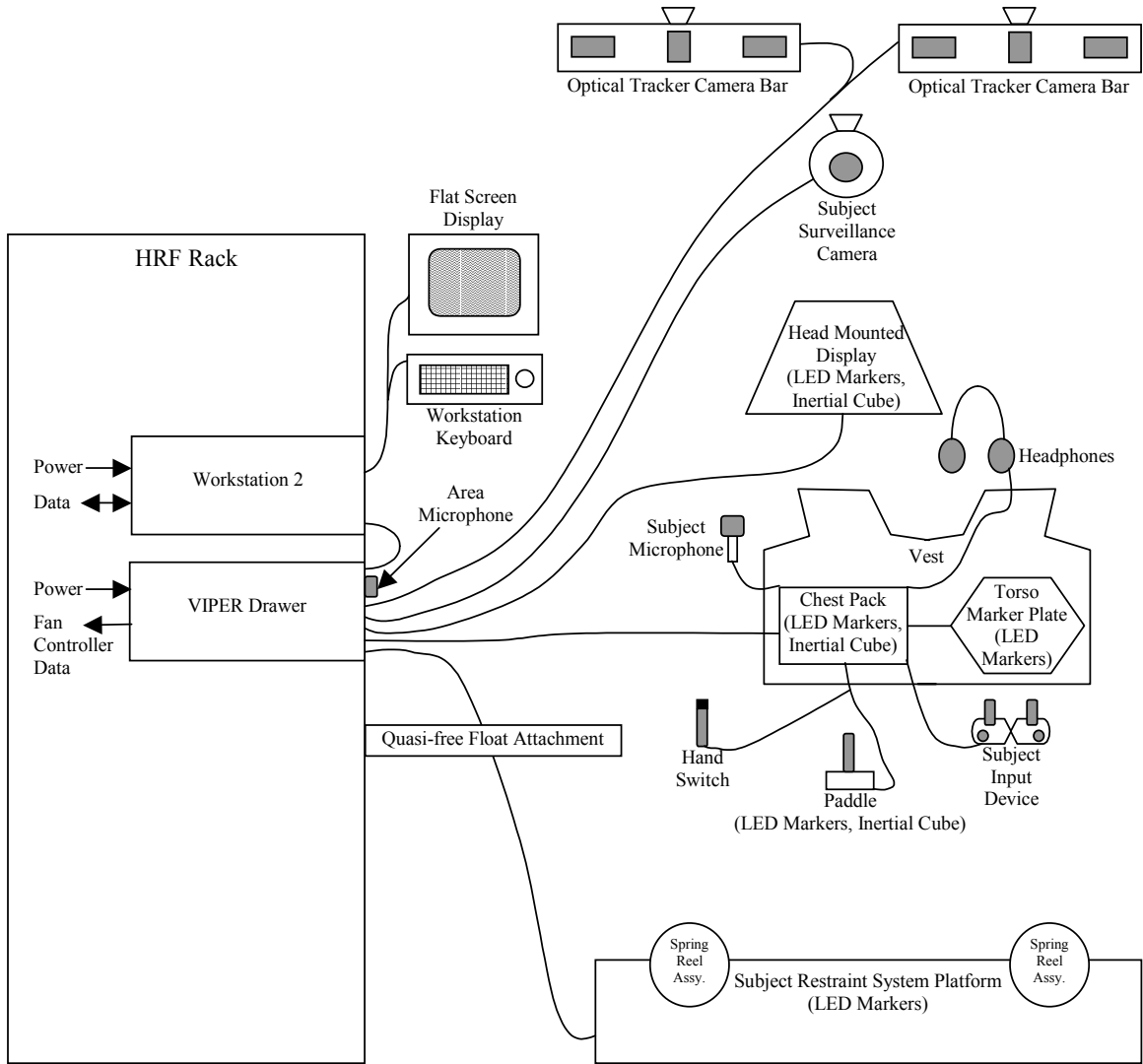


Figure 1-1 VOILA hardware block diagram

2 Component Nomenclature

Per the Hardware Requirements Document (HRD) the following component assemblies comprise one Flight Set of VOILA hardware.

| Name | Part Number | Quantity | Notes |
|--------------------|-----------------|----------|---|
| EE | 85-30100 | 1 | Electronics Enclosure (mounts in HRF Rack) |
| Tracker Bar | 85-20100 | 2 | Supplied by Chamwood Dynamics |
| Head Display | 85-40100 | 1 | Supplied by nVis |
| Chestpack | 85-40400 | 1 | |
| Headphones | 85-41000 | 1 | Supplied by Bose |
| Joystick | 85-40600 | 1 | |
| Paddle | 85-40500 | 1 | |
| Subject Camera | 85-41200 | 1 | |
| Restraint Platform | 85-40300 | 1 | |
| Restraint Pole | 85-40700 | 1 | |
| Marker Plate | 85-40900 | 1 | |
| Cal Bar A | 85-41300 | 1 | |
| Cal Bar B | 85-41400 | 1 | |
| Restraint Spring | SEG46119710-301 | 2 | Supplied by JSC |
| Vest | SEG46119738-310 | 1 | Supplied by JSC |
| WS2 Cable | 85-40801 | 1 | Connects EE to Rack 2 Workstation |
| Tracker Bar Cable | 85-40803 | 2 | Connects EE to Tracker Bar |
| Chestpack Cable | 85-40806 | 1 | Connects EE to Chestpack |

- In the HRD, each name is preceded by the word “VOILA”.

3 Reference Documents

This ICD is intended to be consistent with the following documents.

- Hardware Requirements Document, No JSC Document Number, Rev 05, undated (ref. MIT configuration data base 85-02002)
- Interface Definition Document (IDD) for the Human Research Facility (HRF) Rack 2 Workstation (R2WS), LS-711042-14-4A, 3/18/02.

4 Electrical

4.1 Primary Power

Only the Electronics Enclosure interfaces directly to the primary Station 28VDC bus. Characteristics of this power are governed by para. 3.2,7.2 of the HRD. A 7.5A circuit breaker switches the power received by the EE. Operating voltage ranges from 25.5 to 29.5 VDC.

Nominal power drain for the operating experiment is 110 watts, independent of bus voltage. Maximum power is 130 watts.

Refer to Section 6 for the distribution of thermal power in each of the VOILA components.

4.2 Signal Interfaces

All signal interfaces external to the VOILA EUE are contained in the WS2 cable connecting the Electronics Enclosure to the Rack 2 Workstation. On the JSC side these signals are defined in the Interface Definition Document (IDD) for the Human Research Facility (HRF) Rack 2 Workstation (R2WS).

4.2.1 WS2-P3 A/D, D/A, DIO

Connector is MS27484T18F35PB. Pins not listed below are open.

| Pin No. | VOILA Signal Name | R2WS Signal Name |
|---------|-------------------|------------------|
| 4 | CHAN0_ACCL_X+ | IN0+ |
| 5 | CHAN0_ACCL_X- | IN0- |
| 1 | CHAN0_SHD | SHD |
| 6 | CHAN1_ACCL_Y+ | IN1+ |
| 7 | CHAN1_ACCL_Y- | IN1- |
| 2 | CHAN1_SHD | SHD |
| 8 | CHAN2_ACCL_Z+ | IN2+ |
| 9 | CHAN2_ACCL_Z- | IN2- |
| 3 | CHAN2_SHD | SHD |
| 10 | CHAN3_HSKPG+ | IN3+ |
| 11 | CHAN3_HSKPG- | IN3- |
| 18 | CHAN3_SHD | SHD |
| 12 | CHAN4_VSYNCRT+ | IN4+ |
| 13 | CHAN4_VSYNCRT- | IN4- |
| 20 | CHAN4_SHD | SHD |
| 14 | CHAN5_VSYNCLF+ | IN5+ |
| 15 | CHAN5_VSYNCLF- | IN5- |
| 22 | CHAN5_SHD | SHD |
| | | |
| 47 | DIG_OUT_0+ | DIG_OUT0 |
| 48 | DIG_OUT0- | DIG_OUT0- |
| 55 | DIG_OUT_0_SHD | SHD |
| 49 | DIG_OUT_1+ | DIG_OUT1+ |
| 50 | DIG_OUT_1- | DIG_OUT1- |
| 57 | DIG_OUT_1_SHD | SHD |
| 65 | DIG_IN_0+ | DIG_IN_0 |
| 66 | DIG_IN_0- | DIG_IN_0- |
| 62 | DIG_IN_1+ | DIG_IN_1+ |
| 63 | DIG_IN_1- | DIG_IN_1- |
| 56 | DIG_IN_SHD | SHD |

4.2.2 WS2-P5 NTSC/AUDIO

Connector is MS27484T10F35P. Pins not listed below are open.

| Pin No. | VOILA Signal Name | R2WS Signal Name |
|---------|-------------------|------------------|
| 7 | BOOM_MIC_OUT | Mic In |
| 8 | BOOM_MIC_OUT_RTN | Mic/Line GND |
| 9 | BOOM_MIC_SHD | Mic/Line SHD |

4.2.3 WS2-P6 IRIG-B

Connector is MS27484T10F35PA. Pins not listed below are open.

| Pin No. | VOILA Signal Name | R2WS Signal Name |
|---------|-------------------|------------------|
| 3 | EXT_TRIG+ | DAS-TRIGHI |
| 6 | EXT_TRG- | DAS-TRIGLO |
| 9 | EXT_TRG_SHD | DAS-SHD |

4.2.4 WS2-P7 RGB VIDEO

Connector is MS27484T14F35PC. Pins not listed below are open.

| Pin No. | VOILA Signal Name | R2WS Signal Name |
|---------|-------------------|------------------|
| 1 | REDLFVID | REDLFOUT |
| 2 | REDLFVID_GND | GND |
| 3 | GRNLFVID | GRNLFOUT |
| 4 | GRNLFVID_GND | GND |
| 5 | BLUFVID | BLULFOUT |
| 6 | BLULFVID_GND | GND |
| 7 | HSYNCLF | HSLFOUT |
| 8 | HSYNCLF_GND | GND |
| 9 | VSYNCLF | VSLFOUT |
| 10 | VSYNCLF_GND | GND |
| 11 | REDRTVID | REDRTOUT |
| 12 | REDRTVID_GND | GND |
| 13 | GRNRVID | GRNRTOUT |
| 14 | GRNRVID_GND | GND |
| 15 | BLURTVID | BLURTOUT |
| 16 | BLURTVID_GND | GND |
| 17 | HSYNCRT | HSRTOUT |
| 18 | HSYNCRT_GND | GND |
| 19 | VSYNCRT | VSRTOUT |
| 20 | VSYNCRT_GND | GND |

4.2.5 WS2-P9 Ethernet

Connector is MS27484T8F35P. Pins not listed below are open.

| Pin No. | VOILA Signal Name | R2WS Signal Name |
|---------|-------------------|------------------|
| 1 | ENET_TX+ | TX+ |
| 5 | ENET_TX- | TX- |
| 6 | ENET_TX_SHD | TX SHD |
| 3 | ENET_RX+ | RX+ |
| 4 | ENET_RX- | RX- |
| 2 | ENET_RX_SHD | RX SHD |

4.2.6 WS2-P10 USB/IEEE 1394

Connector is MS27484T12F35P. Pins not listed below are open.

| Pin No. | VOILA Signal Name | R2WS Signal Name |
|---------|-------------------|-----------------------|
| 1 | USB0_PWR | USB0 PWR |
| 4 | USB0_GND | USB0 GND |
| 2 | USB0+ | USB0+ |
| 3 | USB0- | USB0- |
| 9 | USB0_SHD | SHIELD (USB, chassis0 |
| 5 | USB1_PWR | USB1 PWR |
| 8 | USB1_GND | USB1 GND |
| 6 | USB1+ | USB1+ |
| 7 | USB1- | USB1- |
| 10 | USB1_SHD | SHIELD (IEEE 1394) |

5 Thermal

Thermal power dissipation in watts is given for each component in both idle and active mode.

| Name | Part Number | Quantity | Estimated Unit Power | Estimated Total Pwr. | Maximum Total Pwr. |
|--------------------|-----------------|----------|----------------------|----------------------|--------------------|
| EE | 85-30100 | 1 | | 72.3 | |
| Tracker Bar | 85-20100 | 2 | 11.0 | 22.0 | |
| Head Display | 85-40100 | 1 | | 9.3 | |
| Chestpack | 85-40400 | 1 | No active components | | |
| Headphones | 85-41000 | 1 | | <0.1 | |
| Joystick | 85-40600 | 1 | | <0.1 | |
| Paddle | 85-40500 | 1 | | 3.2 | |
| Subject Camera | 85-41200 | 1 | | 1 | |
| Restraint Platform | 85-40300 | 1 | No active components | | |
| Restraint Pole | 85-40700 | 1 | No active components | | |
| Marker Plate | 85-40900 | 1 | | 2.9 | |
| Cal Bar A | 85-41300 | 1 | | <0.1 | |
| Cal Bar B | 85-41400 | 1 | | <0.1 | |
| Restraint Spring | SEG46119710-301 | 2 | No active components | | |
| Vest | SEG46119738-310 | 1 | | | |
| WS2 Cable | 85-40801 | 1 | | | |
| Tracker Bar Cable | 85-40803 | 2 | | | |
| Chestpack Cable | 85-40806 | 1 | | | |

6 Mechanical

6.1 Mass

Masses are reported in grams.

| Name | Part Number | Quantity | Estimated Unit Mass | Estimated Total Mass | Maximum Total Mass |
|--------------------|-----------------|----------|---------------------|----------------------|--------------------|
| Tracker Bar | 85-20100 | 2 | 5,670 | 11,240 | |
| Head Display | 85-40100 | 1 | 2,721 | 2,721 | |
| Chestpack | 85-40400 | 1 | 635 | 635 | |
| Headphones | 85-41000 | 1 | 181 | 181 | |
| Joystick | 85-40600 | 1 | 204 | 204 | |
| Paddle | 85-40500 | 1 | 1,157 | 1,157 | |
| Subject Camera | 85-41200 | 1 | 760 | 760 | |
| Restraint Platform | 85-40300 | 1 | 13,608 | 13,608 | |
| Restraint Pole | 85-40700 | 1 | 2,631 | 2,631 | |
| Marker Plate | 85-40900 | 1 | 998 | 998 | |
| Cal Bar A | 85-41300 | 1 | 1,769 | 1,769 | |
| Cal Bar B | 85-41400 | 1 | 1,633 | 1,633 | |
| Restraint Spring | SEG46119710-301 | 2 | 3,084 | 6,168 | |
| Vest | SEG46119738-310 | 1 | 952 | 952 | |
| WS2 Cable | 85-40801 | 1 | 1,588 | 1,588 | |
| Tracker Bar Cable | 85-40803 | 2 | 2,087 | 4,174 | |
| Chestpack Cable | 85-40806 | 1 | 1,860 | 1,860 | |
| Total Stowed Mass | | | | 36,299 | 43,559 |
| EE | 85-30100 | 1 | | | |
| MIT Components | | | | 9,071 | |
| JSC Components | | | | n/a | |
| Total Rack 2 Mass | | | | n/a | 29,030 |

6.2 Outline Drawings

The following pages are copied from drawings in the VOILA database. They show both the deployed and stowed (where appropriate) outline dimensions of the various components.

The only MIT-provided hard mechanical interfaces to the Station are to seat tracks. These are indicated in the drawings for the Tracker Bar, Subject Camera, Cal Bars, Restraint Pole, and Restraint Platform. The EE is a standard HRF drawer supplied by JSC.

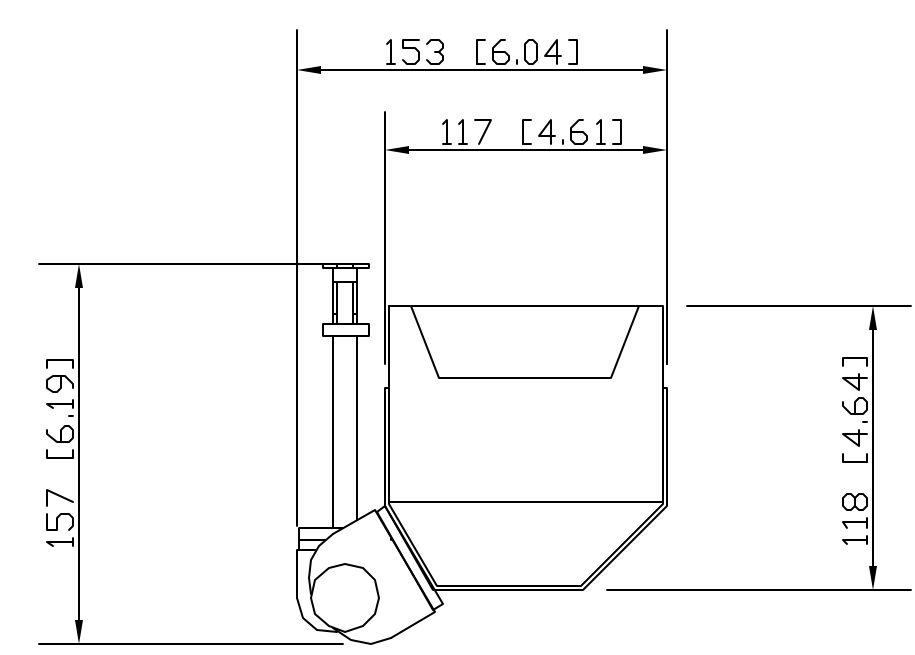
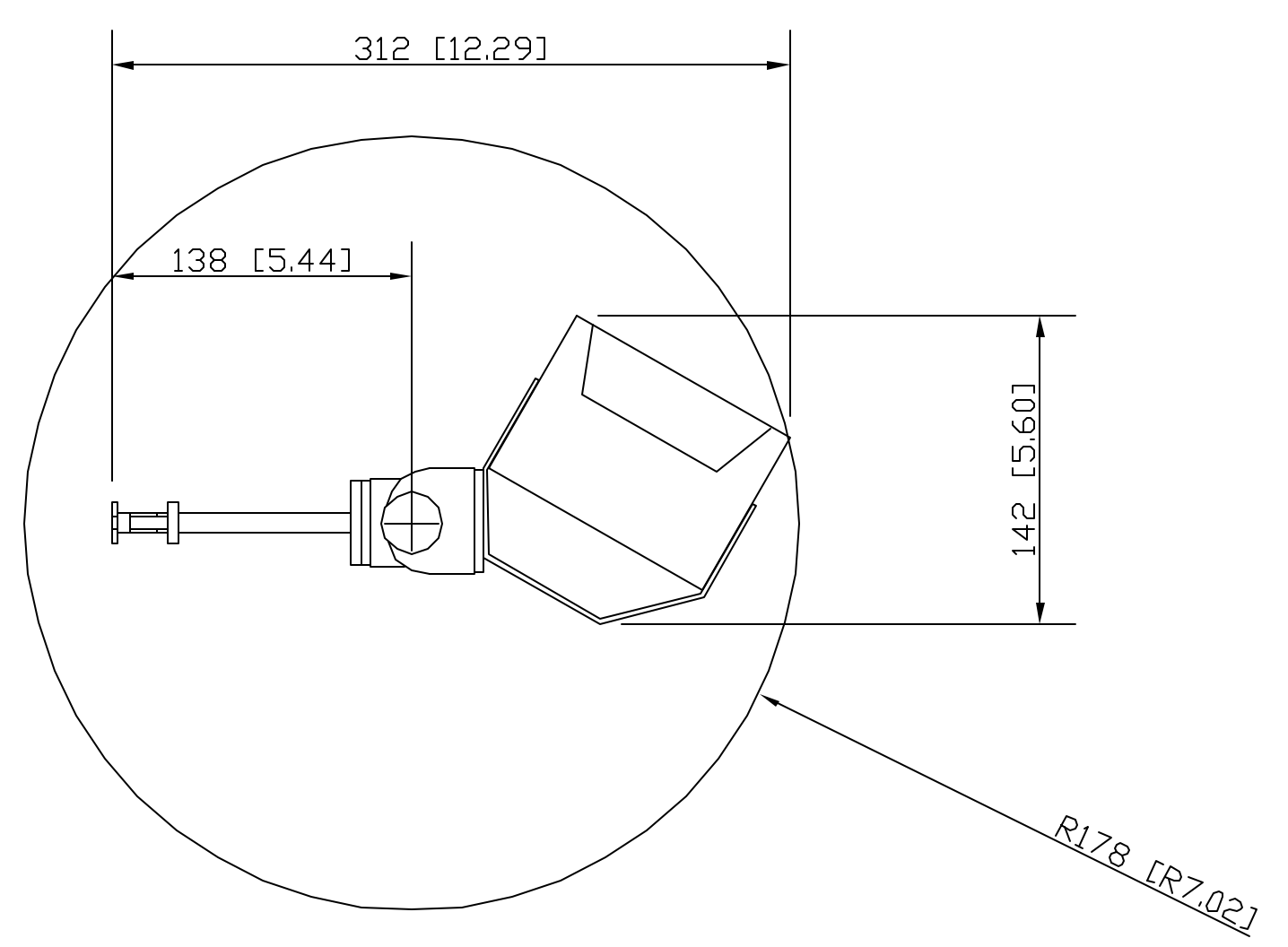
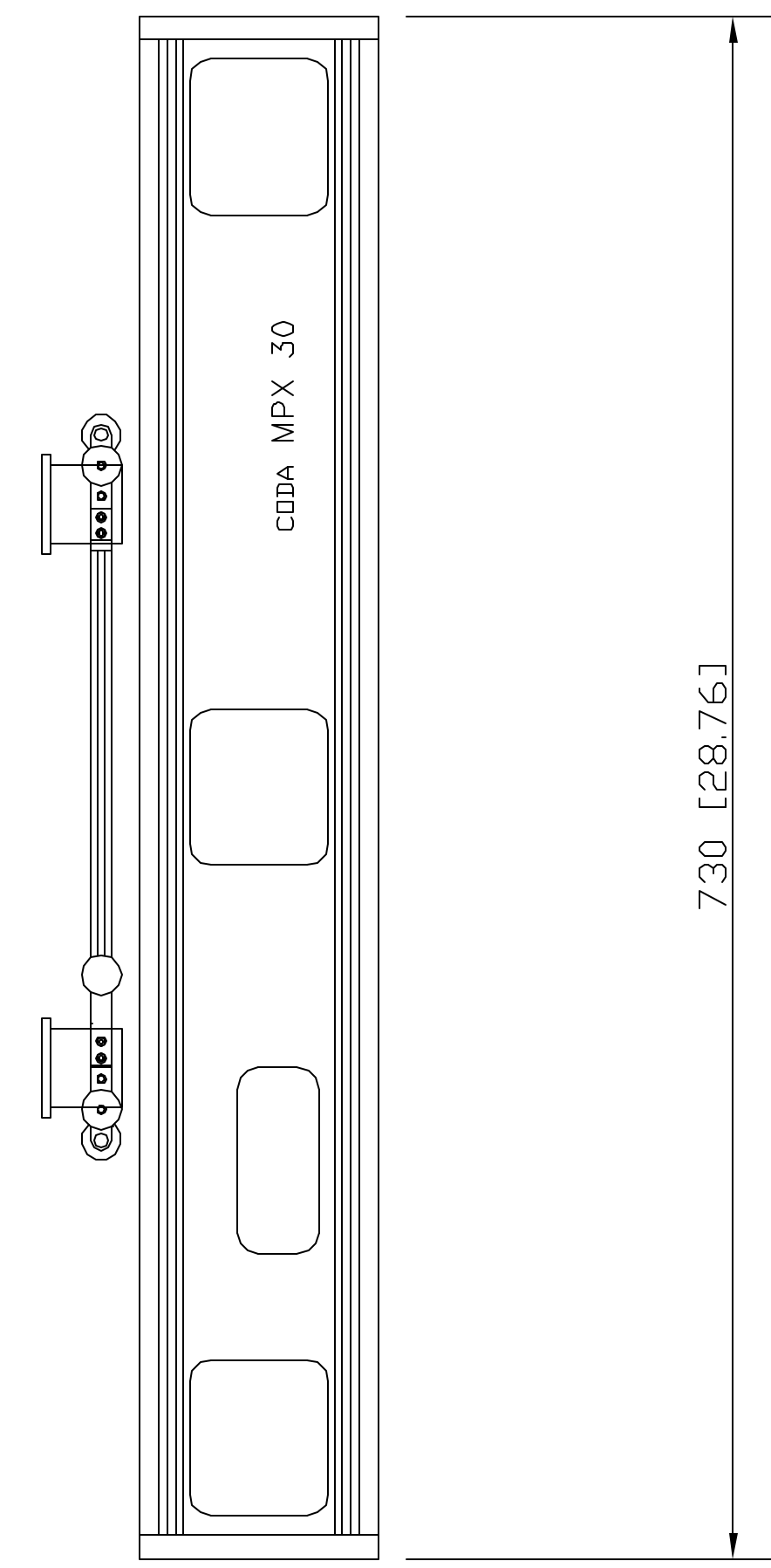
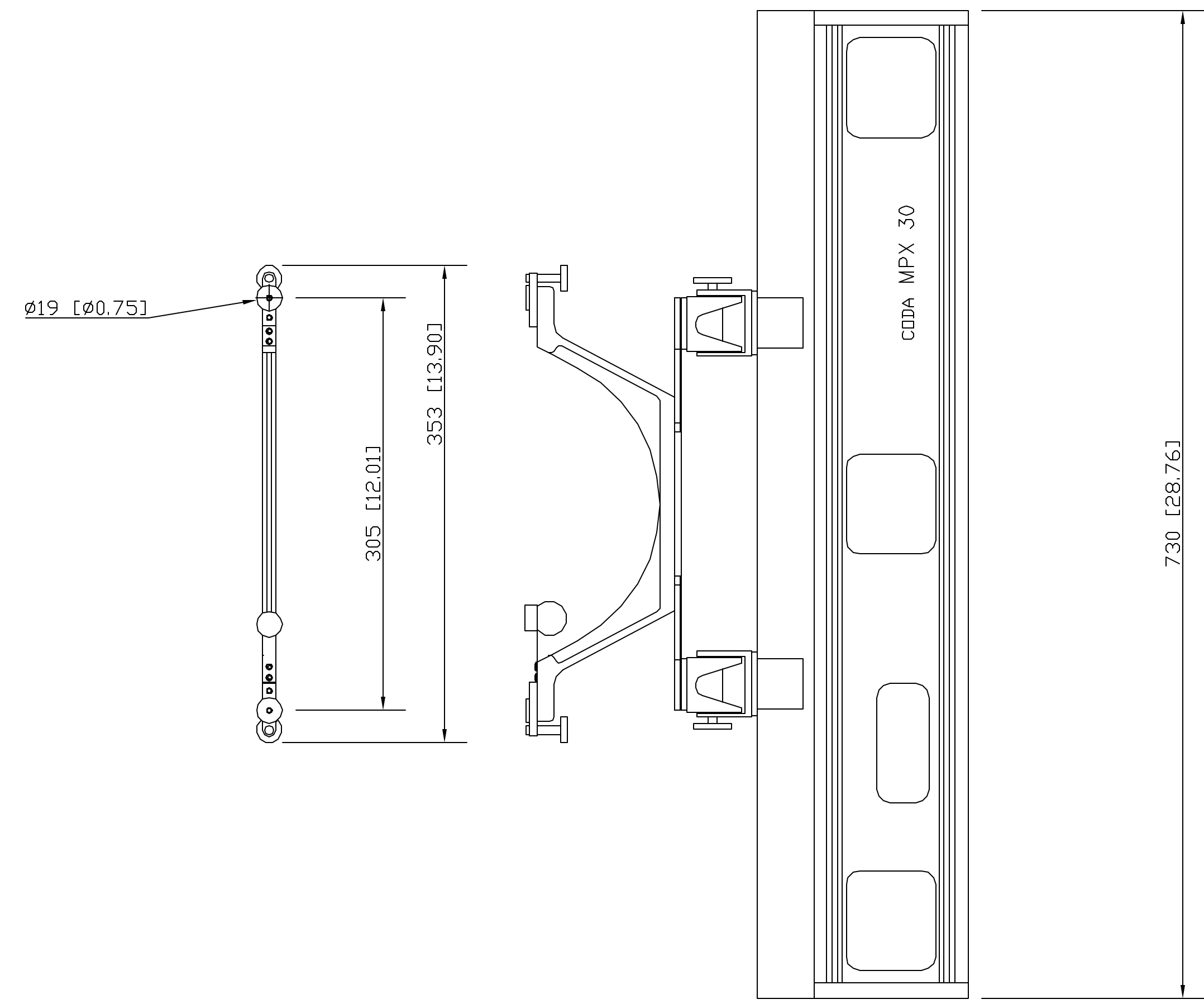
| Name | Part Number | ICD Drawing |
|--------------------|-----------------|-------------|
| EE | 85-30100 | |
| Tracker Bar | 85-20100 | 85-20100.99 |
| Head Display | 85-40100 | 85-40100.99 |
| Chestpack | 85-40400 | 85-40400.99 |
| Headphones | 85-41000 | 85-41000.99 |
| Joystick | 85-40600 | 85-tbd |
| Paddle | 85-40500 | 85-40500.99 |
| Subject Camera | 85-41200 | 85-41200.99 |
| Restraint Platform | 85-40300 | 85-tbd |
| Restraint Pole | 85-40700 | 85-tbd |
| Marker Plate | 85-40900 | 85-40900.99 |
| Cal Bar A | 85-41300 | 85-41300.99 |
| Cal Bar B | 85-41400 | 85-41400.99 |
| Restraint Spring | SEG46119710-301 | |
| Vest | SEG46119738-310 | |
| WS2 Cable | 85-40801 | 85-tbd |
| Tracker Bar Cable | 85-40803 | 85-tbd |
| Chestpack Cable | 85-40806 | 85-tbd |

8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

| REVISIONS | | | |
|-----------|-----|-----------------|------|
| ECO | REV | DESCRIPTION | DATE |
| 85-94 | 01 | INITIAL RELEASE | |

DEPLOYED

STOWED



NOTES:
1. DIMENSIONS ARE IN mm [IN].

| | | | | | |
|--|---------|----------|----------|---|--------------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- .1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA | |
| 85- | VOILA | DRAWN | M. SMITH | 4/7/04 | ICD TRACKER BAR |
| NEXT ASSEMBLY | USED ON | CHECKED | | | |
| APPLICATION | WEIGHT | APPROVED | | | |
| | | RELEASED | | | SIZE |
| | | FINISH | | | D |
| | | | | | FSDM NO. |
| | | | | | 80230 |
| | | | | | DWG NO. |
| | | | | | 85-20100.99 |
| | | | | | REV |
| | | | | | 01 |
| | | | | | SCALE |
| | | | | | 1:1 |
| | | | | | SHEET |
| | | | | | 1 OF 1 |

8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

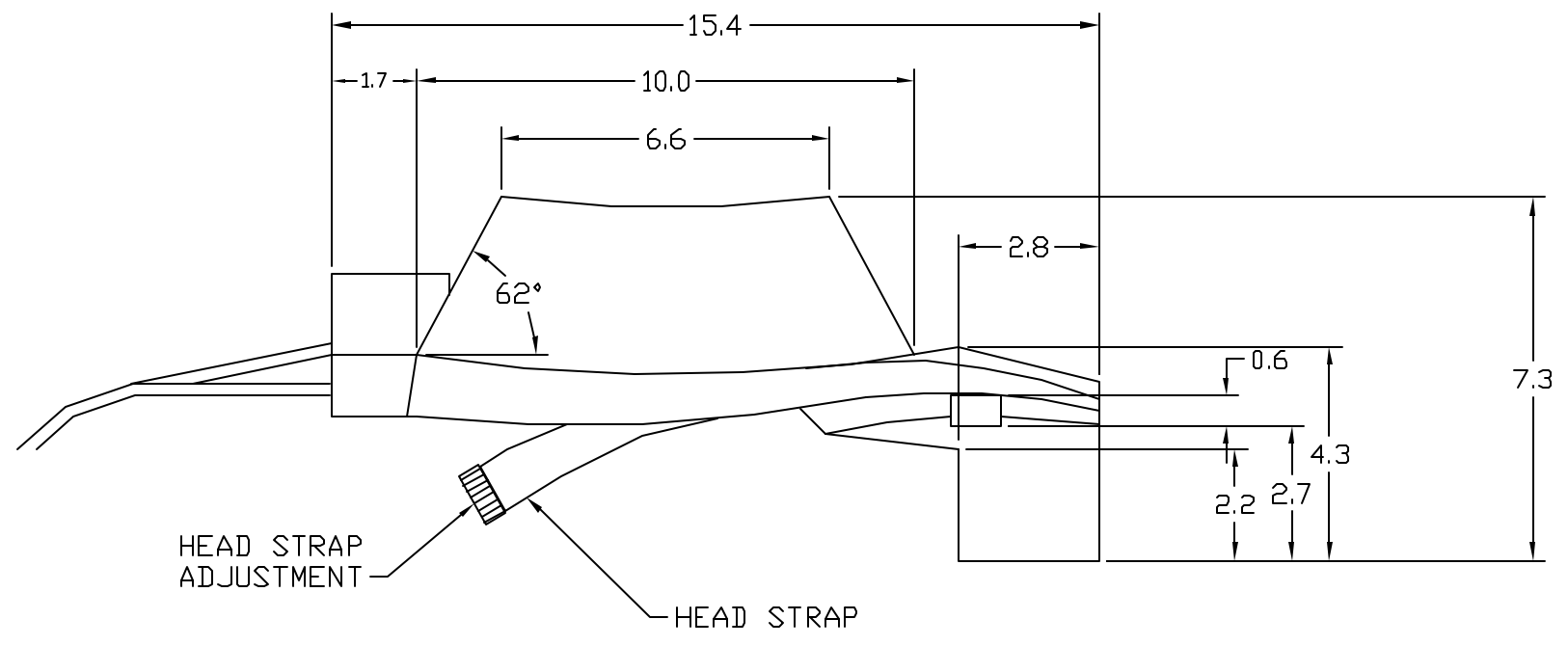
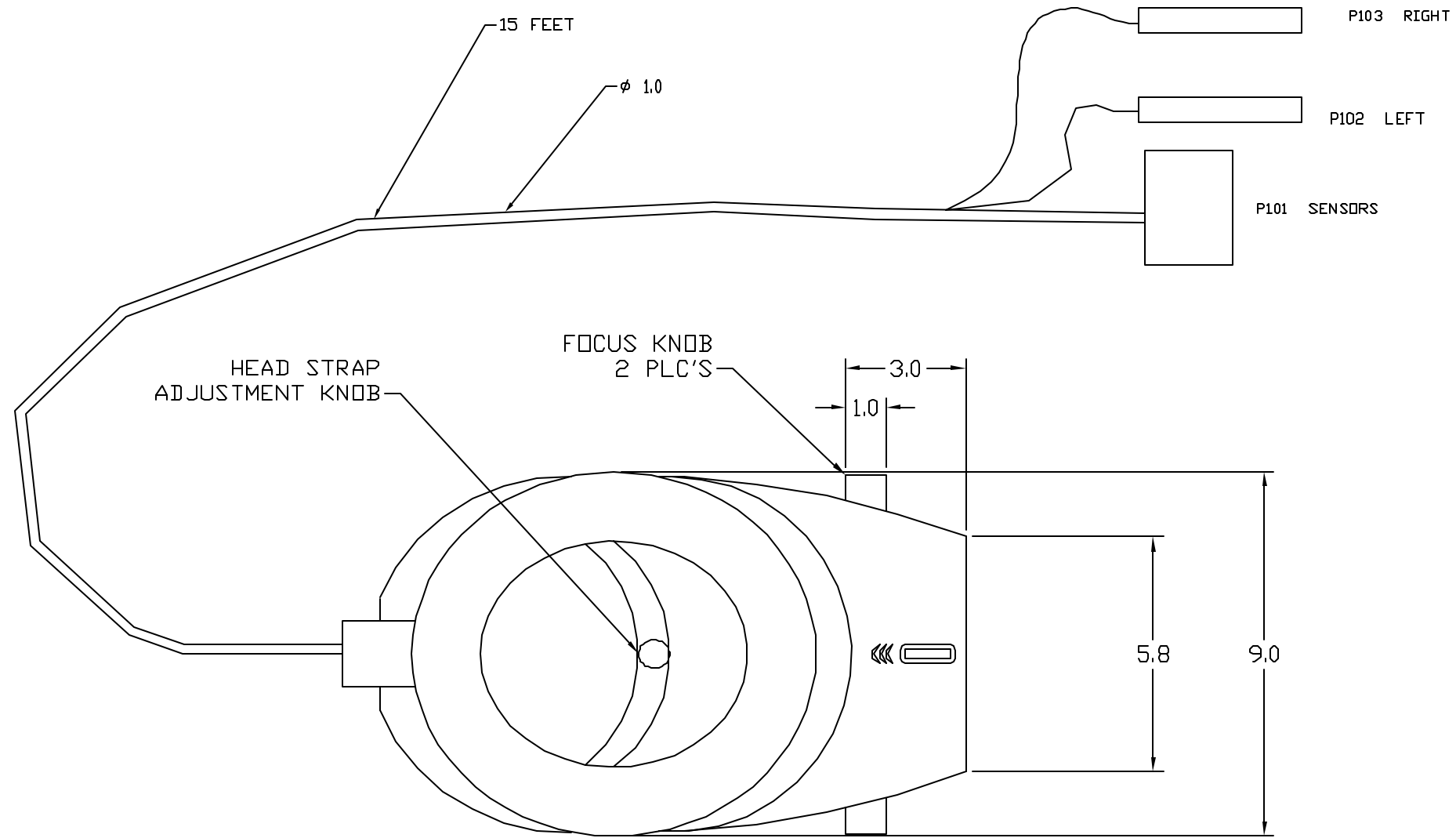
4

3

2

1

| REVISIONS | | | | | |
|-----------|-----|-------------|---------|----------|------|
| ECO | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-94 | 01 | PRE RELEASE | | | |



- NOTES:
1. ALL DIMENSIONS ARE IN INCHES.
 2. CABLE COIL DIAMETER IS 10.0" X 2" HIGH.
 3. SERIAL NUMBERS STARTING WITH 100 ARE TRAINING UNITS.
SERIAL NUMBERS STARTING WITH 300 ARE FLIGHT UNITS.

| | | | | | | | | |
|---------------|---------|---|----------|------|---|--|--|--|
| | | UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA | | | |
| | | | DRAWN | | ICD HEAD DISPLAY ASSEMBLY | | | |
| | | MATERIAL | CHECKED | | | | | |
| 85-40100 | VOILA | N/A | APPROVED | | SCALE 1:1 SHEET 1 OF 1 | | | |
| NEXT ASSEMBLY | USED ON | N/A | RELEASED | | | | | |
| APPLICATION | | WEIGHT: 6.0 -6.25 LBS | | | | | | |

4

3

2

1

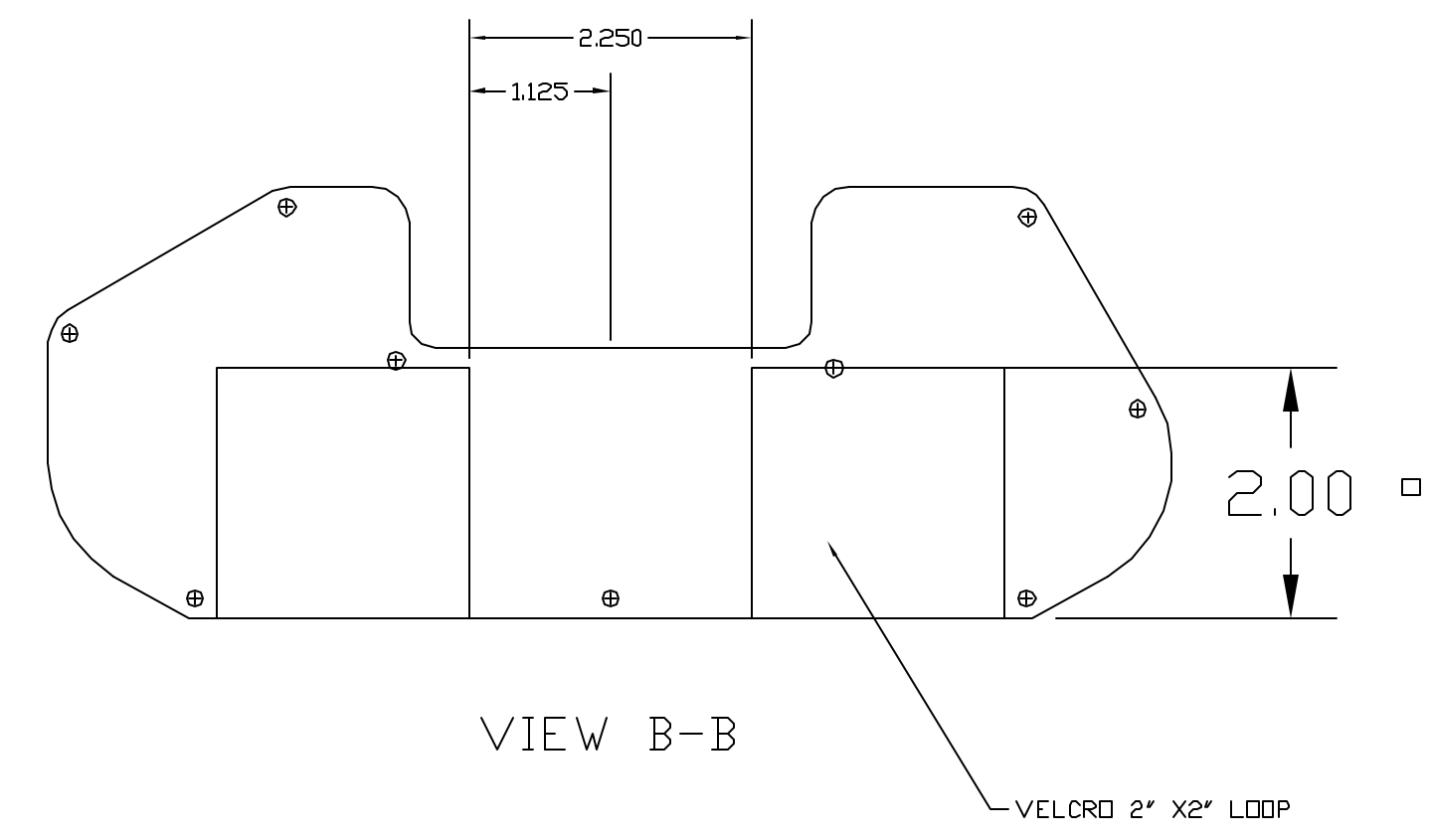
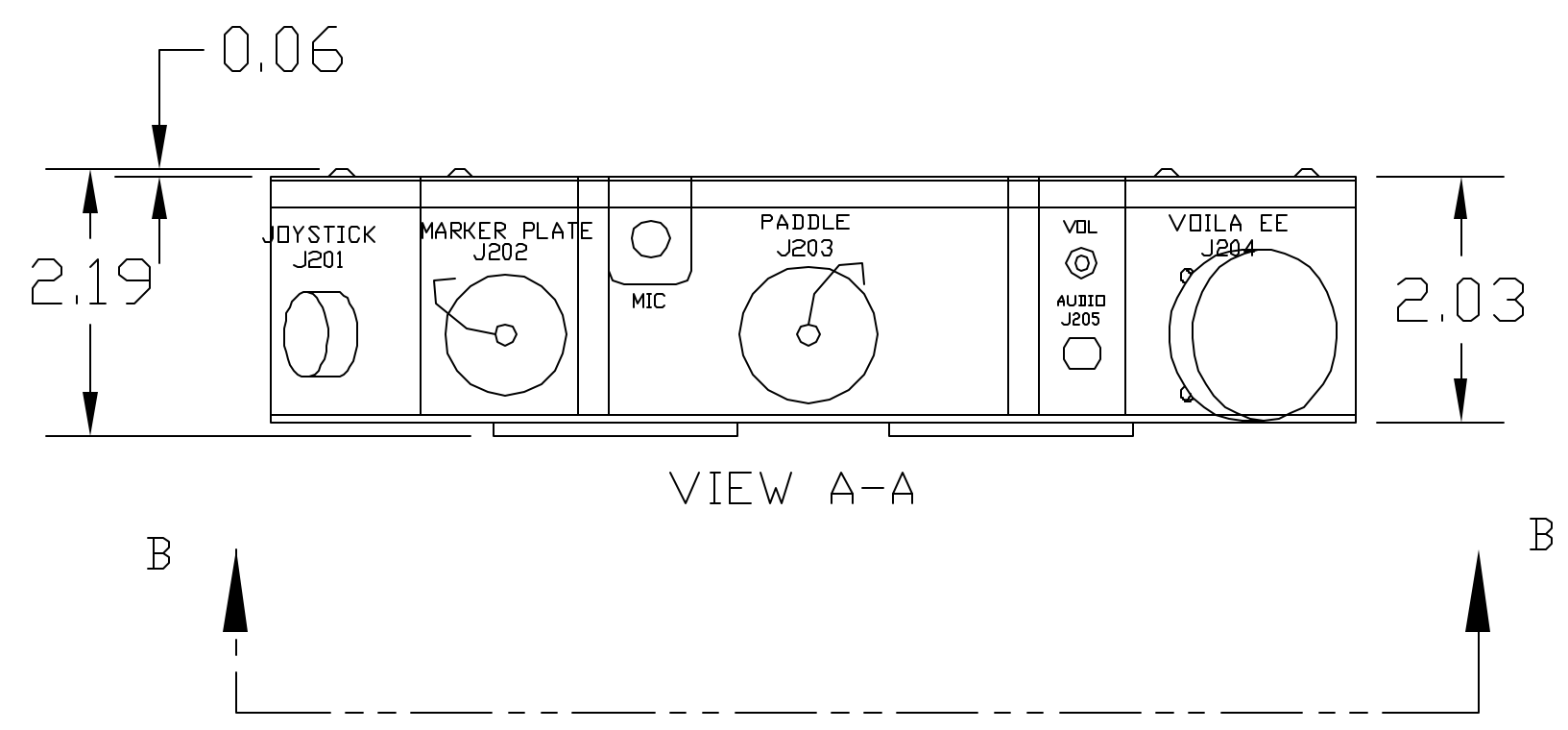
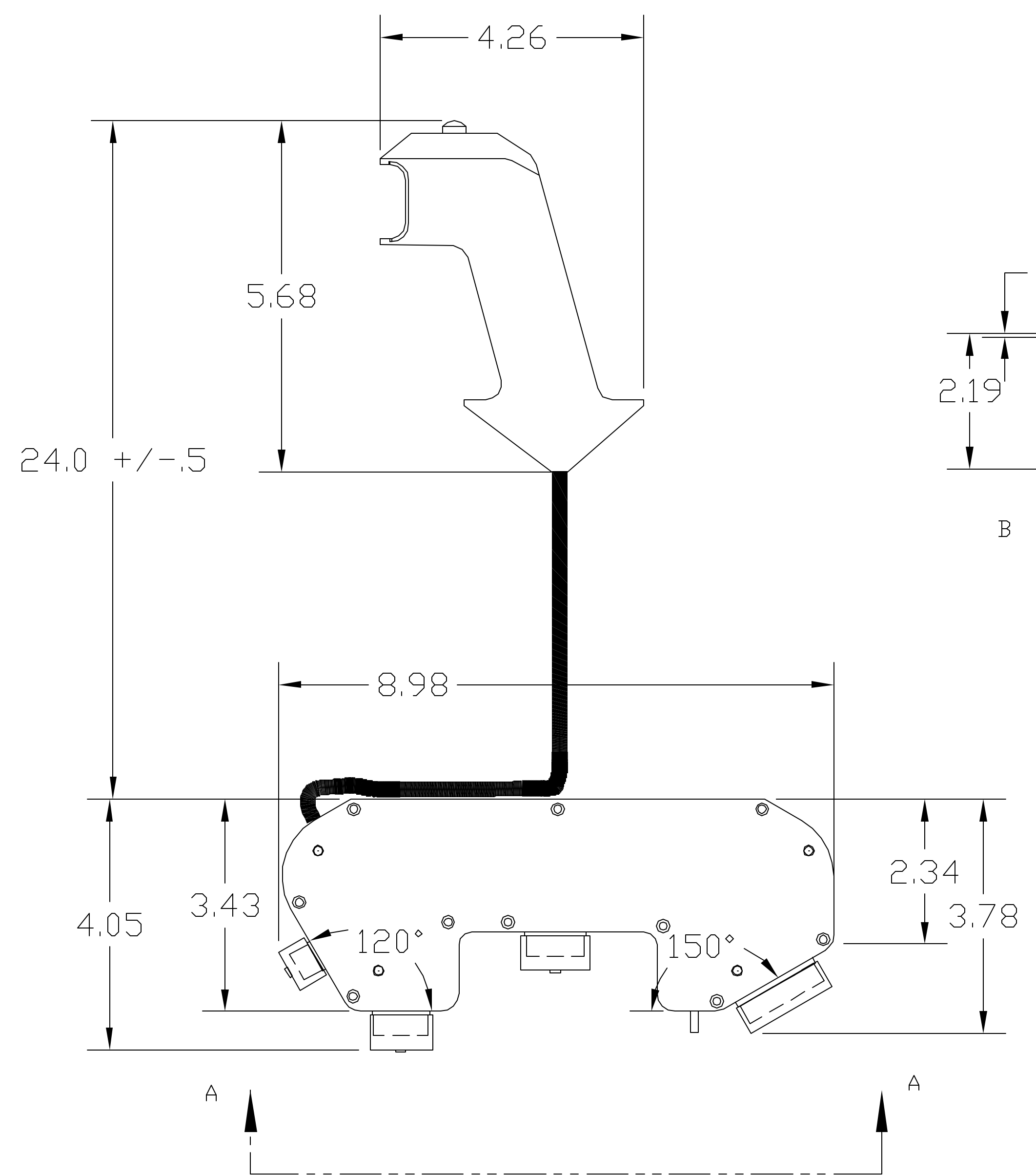
4

3

2

1

| REVISIONS | | | | | |
|-----------|-----|-------------|---------|----------|------|
| ZONE | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-94 | 01 | PRE-RELEASE | | | |
| | | | | | |
| | | | | | |



NOTES,
 1. THE TRIGGER CAN BE WRAPPED AROUND THE CHESTPACK AND VELCRO'D TO THE STRIPS IN THE BACK SIDE.
 2. DIMENSIONS ARE IN INCHES.

| | | | | | | | | |
|---------------|---------|--|----------|----------|---|-------------------------|---------------------|--------|
| | | UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1' 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA PROJECT | | | |
| | | | DRAWN | | | | | |
| | | | MATERIAL | CHECKED | | ICD, CHESTPACK ASSEMBLY | | |
| | | | | APPROVED | | | | |
| | | | | FINISH | | | | |
| 85-40000 | VOILA | | RELEASED | | SIZE E | FSCM NO. 80230 | DWG NO. 85-40400.99 | REV 01 |
| NEXT ASSEMBLY | USED ON | WEIGHT = 1.4-1.8 LBS | CAD FILE | | SCALE 1:1 | | SHEET 1 OF 1 | |

3

2

1

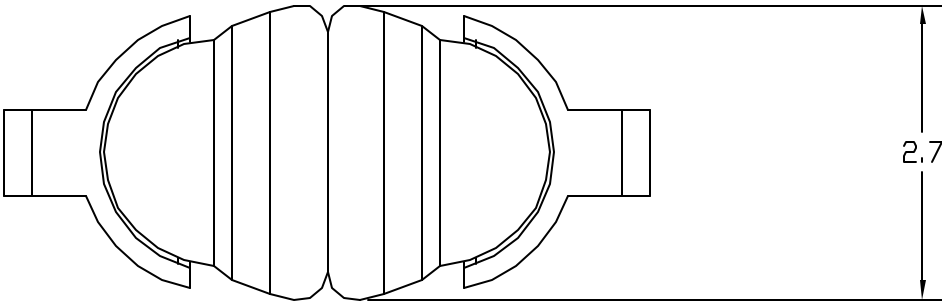
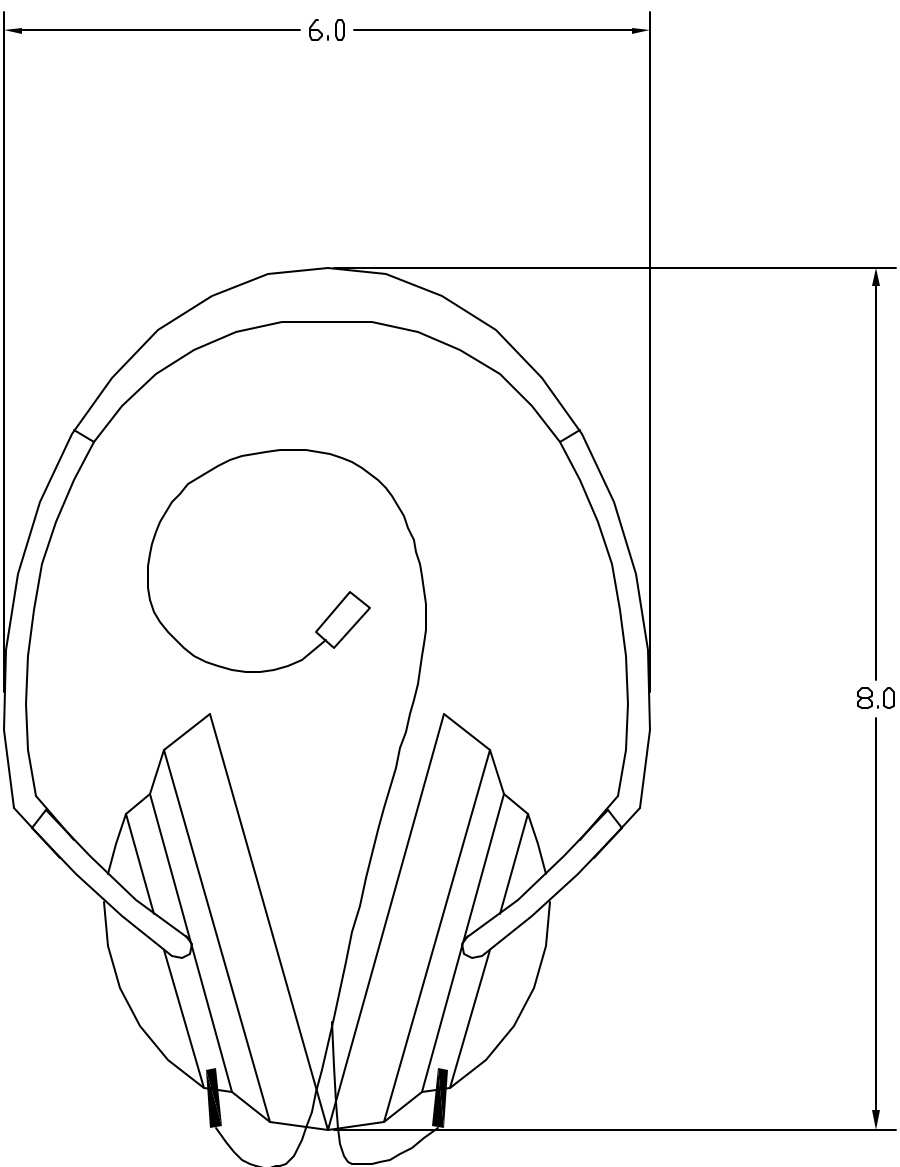
4

3

2

1

| REVISIONS | | | | | |
|-----------|-----|-------------|---------|----------|------|
| ECO | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-94 | 01 | PRE-RELEASE | | | |



- NOTES:
1. DIMENSIONS ARE IN INCHES.
 2. CABLE CAN WRAP WITHIN THE CONFINES OF THE HEADPHONES.
 3. SERIAL NUMBERS STARTING WITH 100 ARE TRAINNG UNITS.
SERIAL NUMBERS STARTING WITH 300 ARE FLIGHT UNITS.

| | | | | | | | | |
|---------------|---------|---|------------------|----------|---|----------|--------------|-----|
| | | UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA | | | |
| | | | DRAWN | | ICD, HEADPHONES | | | |
| | | | CHECKED | | | | | |
| | | | APPROVED | | | | | |
| | | MATERIAL | RELEASED | | SIZE | FSCM NO. | DWG NO. | REV |
| NEXT ASSEMBLY | USED ON | FINISH | | | C | 80230 | 85-41000.99 | 01 |
| APPLICATION | | | WEIGHT .4-.5 LBS | CAD FILE | SCALE | 1:1 | SHEET 1 OF 1 | |

4

3

2

1

8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

| REVISIONS | | | | | |
|-----------|-----|-----------------|---------|----------|------|
| ECO | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-89 | A | INITIAL RELEASE | | | |

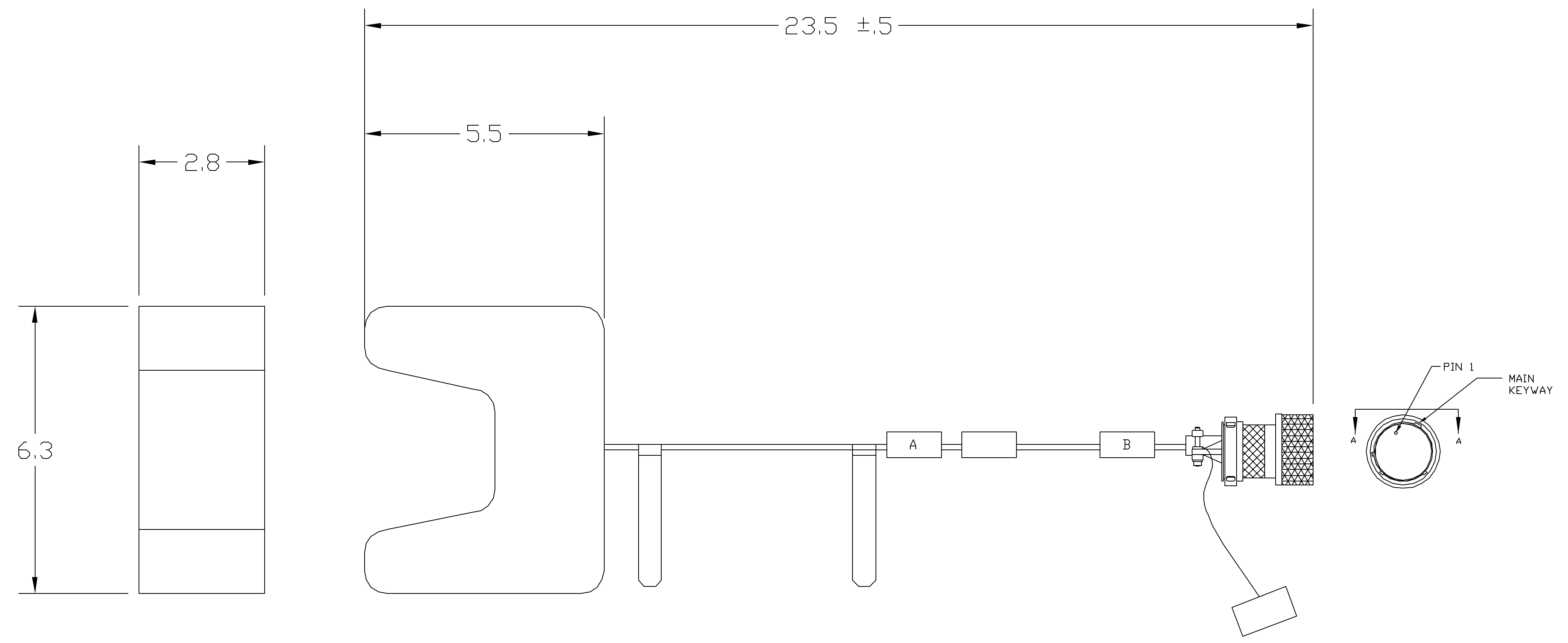


TABLE A

| REF | TEXT |
|-----|--|
| A | VOILA JOYSTICK ASSY P/N 85-40600 S/N YXX |
| B | P201 To VOILA Chestpack JOYSTICK J201 |

NOTES

- SERIAL NUMBERS STARTING WITH 1XX ARE TRAINING UNIT
SERIAL NUMBERS STARTING WITH 3XX ARE FLIGHT UNITS.
- 2. DIMENSIONS ARE IN INCHES.

| | | | | | |
|---|---------------|---------------------|---|--------------------------|------------------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 1 PLACE DECIMAL +/- .2 | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA PROJECT | | |
| | DRAWN | M. SMITH | 12/03/01 | ICD JOYSTICK ASSEMBLY | |
| | CHECKED | | | | |
| | APPROVED | | | | |
| MATERIAL N/A | FINISH N/A | WEIGHT: .45-.50 lbs | SIZE D | FSCM NO. 80230 | DWG NO. 85-40600.99 |
| | | | SCALE 1:1 | SHEET 1 OF 1 | REV A |

8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

| REVISIONS | | | | | |
|-----------|-----|-----------------|---------|----------|------|
| ECO | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-94 | 01 | INITIAL RELEASE | | | |

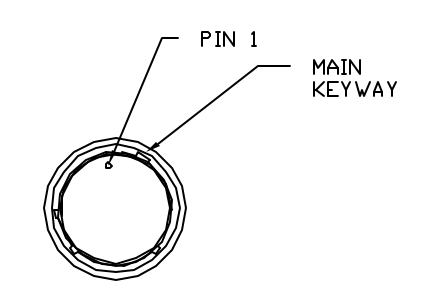
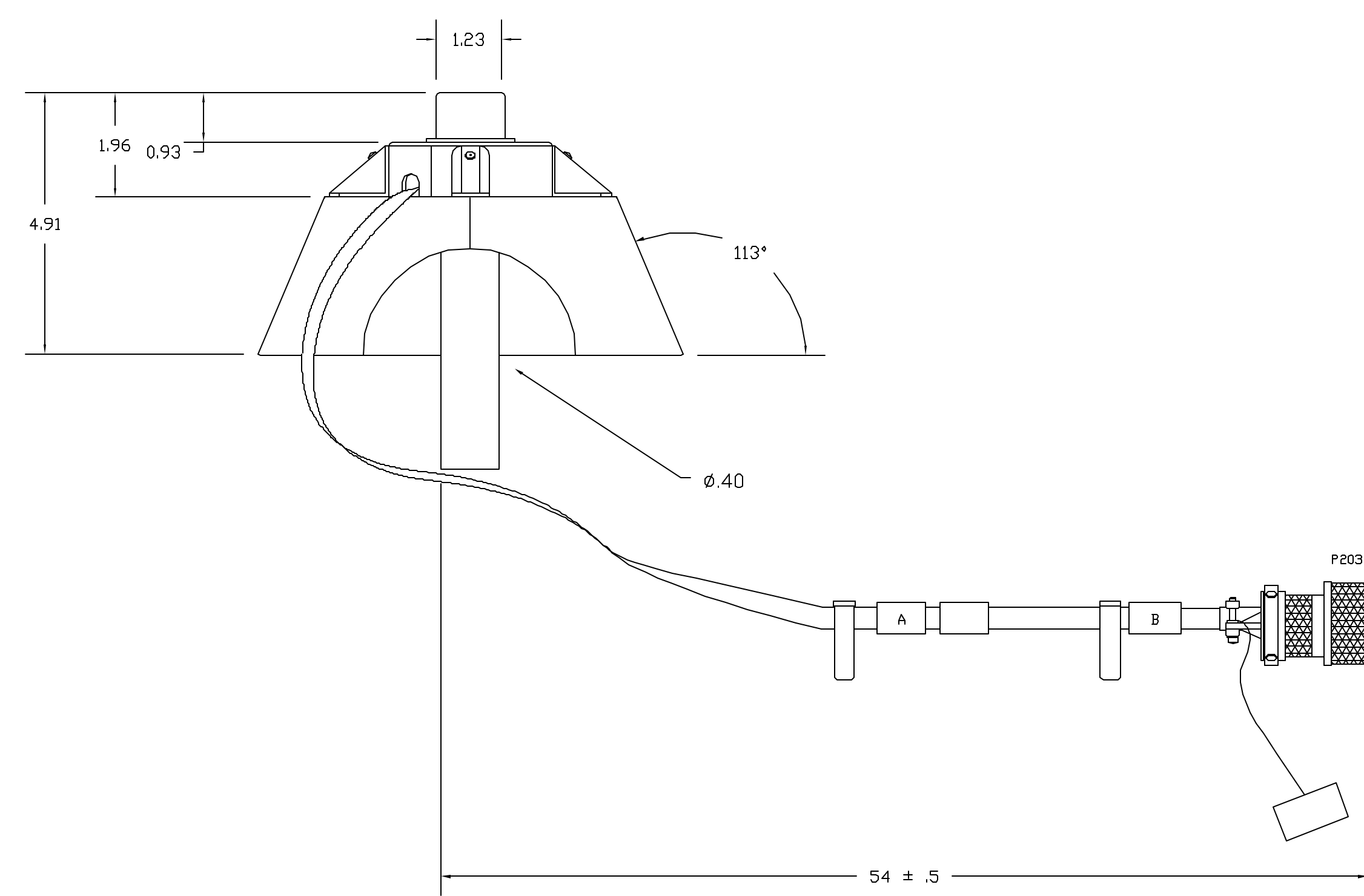
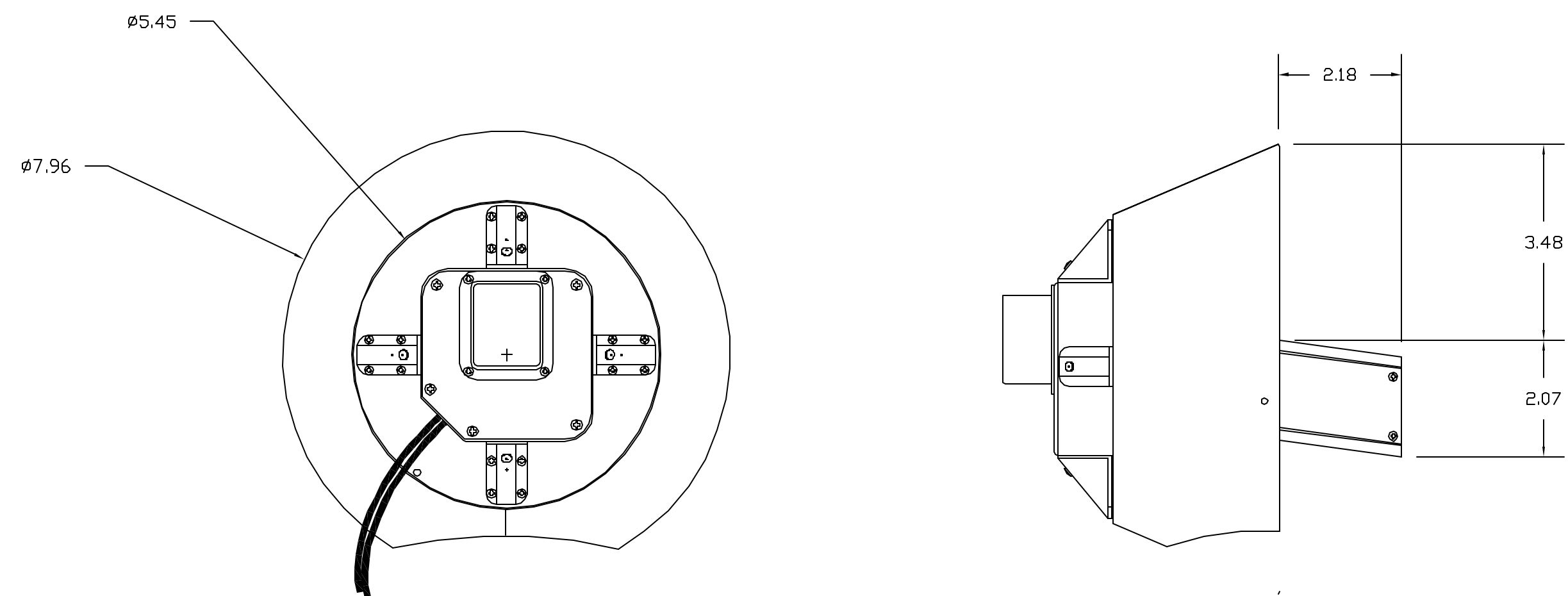


TABLE A

| REF | TEXT |
|-----|--|
| A | VOILA Paddle Assembly P/N 85-40500 S/N YXX 3 |
| B | P203 To VOILA Chestpack PADDLE J203 |

NOTES:
 1. ALL DIMENSIONS ARE IN INCHES.
 2. CABLE COIL DIAMETER IS ABOUT 10" x 2" HIGH.

3 SERIAL NUMBERS STARTING WITH 100 ARE TRAINING UNITS.
 SERIAL NUMBERS STARTING WITH 300 ARE FLIGHT UNITS.

| | | | | |
|---|---------------------|-------------|--------------|---|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- .1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA |
| MATERIAL | | DRAWN | CHECKED | |
| FINISH | | APPROVED | RELEASED | SIZE D |
| VOILA | WEIGHT 2.5- 2.8 LBS | CAD FILE | SCALE 1:1 | FSDM NO. 80230 DWG NO. 85-40500.99 REV 01 |
| NEXT ASSEMBLY | USED ON | APPLICATION | SHEET 1 OF 1 | |

8 7 6 5 4 3 2 1

| REVISIONS | | | | | |
|-----------|-----|-----------------|---------|----------|------|
| ECO | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-88 | 01 | INITIAL RELEASE | | | |

STANDARD SEAT
SEG33105855-301
SEG33107662-001

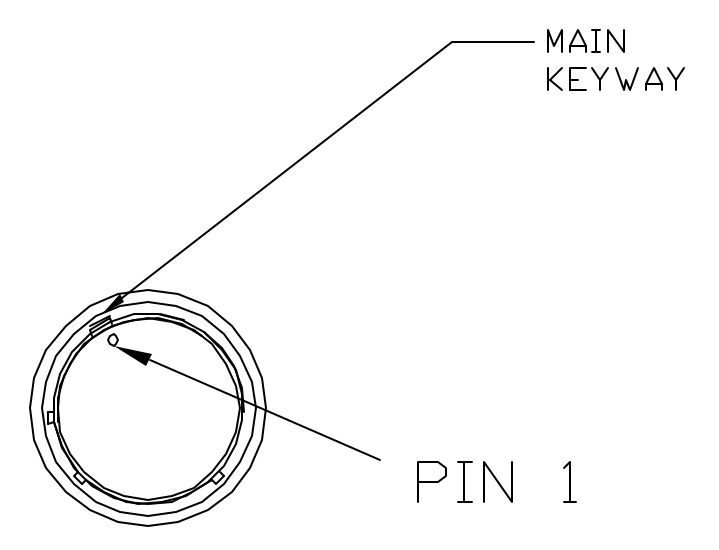
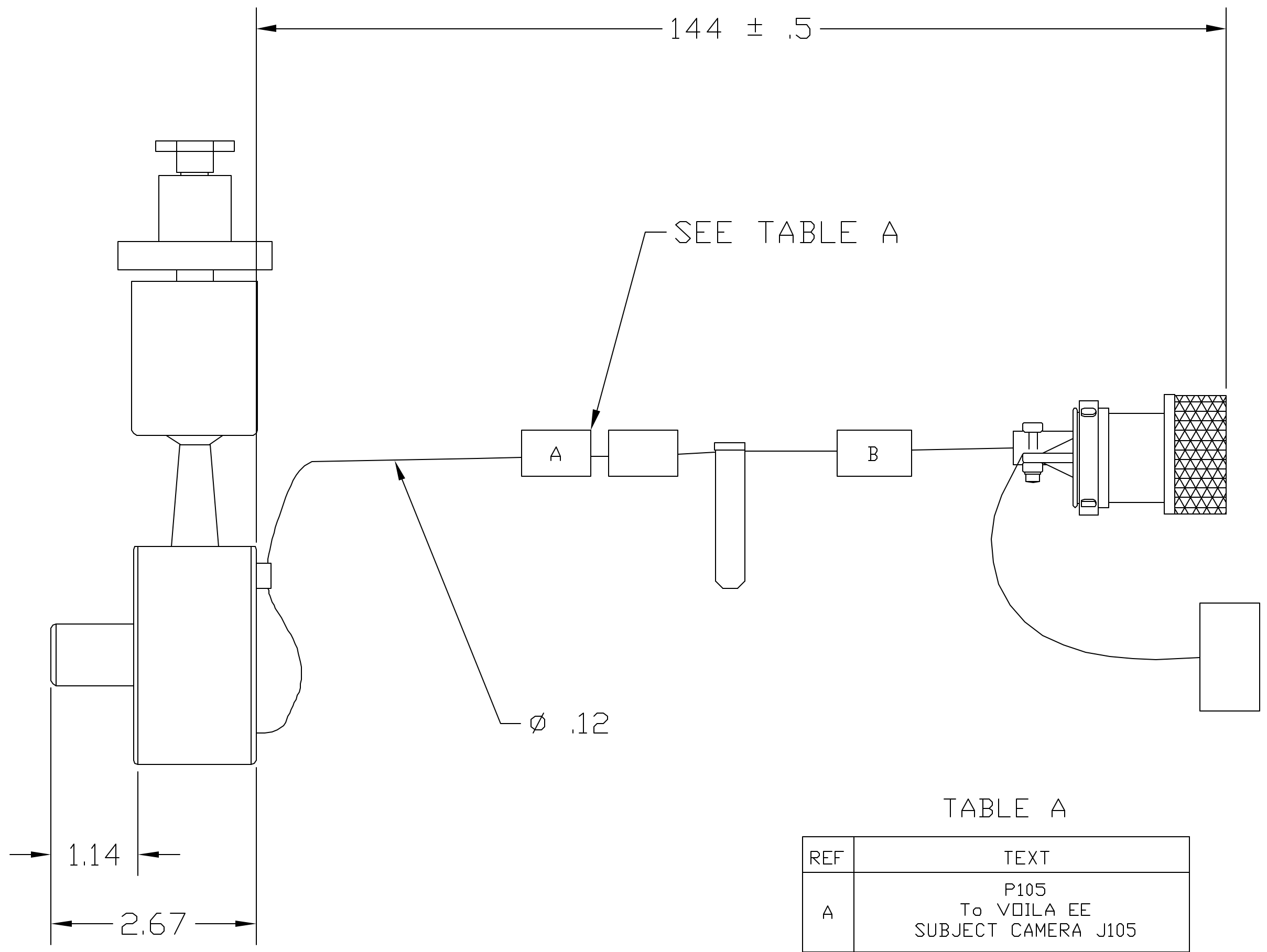
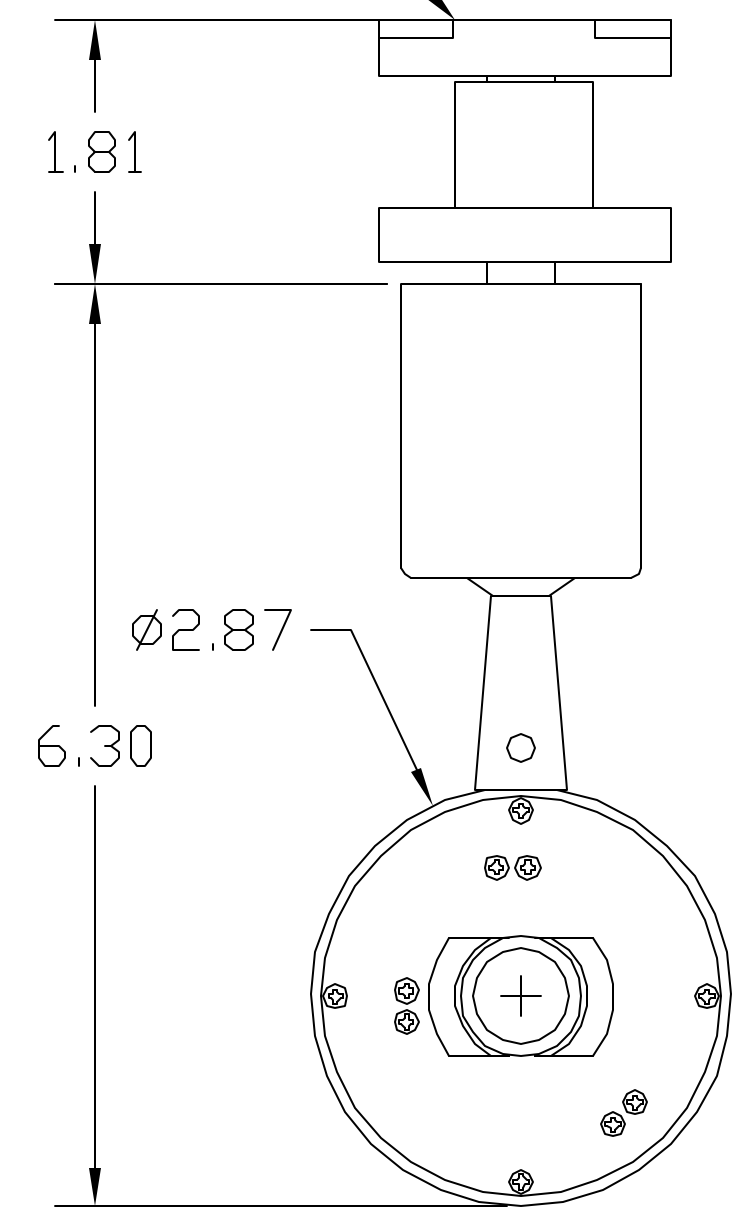


TABLE A

| REF | TEXT |
|-----|--|
| A | P105 To VOILA EE SUBJECT CAMERA J105 |
| B | VOILA Subject Camera Assy P/N 85-41200 S/N YXX 3 |

NOTES:

1. DIMENSIONS ARE IN INCHES.
2. CABLE COIL DIAMETER IS 8" X 1" HIGH.
- 3 SERIAL NUMBERS STARTING WITH 100 ARE TRAINING UNITS.
SERIAL NUMBERS STARTING WITH 300 ARE FLIGHT UNITS.

| | | | | | | |
|---------------|---------|---|------------------|----------|---|-----------------------------------|
| | | UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA | |
| | | | DRAWN | | | |
| | | | MATERIAL N/A | CHECKED | | ICD SUBJECT CAMERA ASSEMBLY |
| | | | | APPROVED | | |
| 85-41200 | VOILA | FINISH | RELEASED | | SIZE D | |
| NEXT ASSEMBLY | USED ON | | WEIGHT .5-.6 lbs | CAD FILE | SCALE 1:1 | FSOM NO. 80230 |
| | | | | | DWG NO. 85-41200.99 | |
| | | | | | REV 01 | |
| | | | | | SHEET 1 OF 1 | |

6 5 4 3 2 1

6.2.8 Restraint Platform (85-40300)

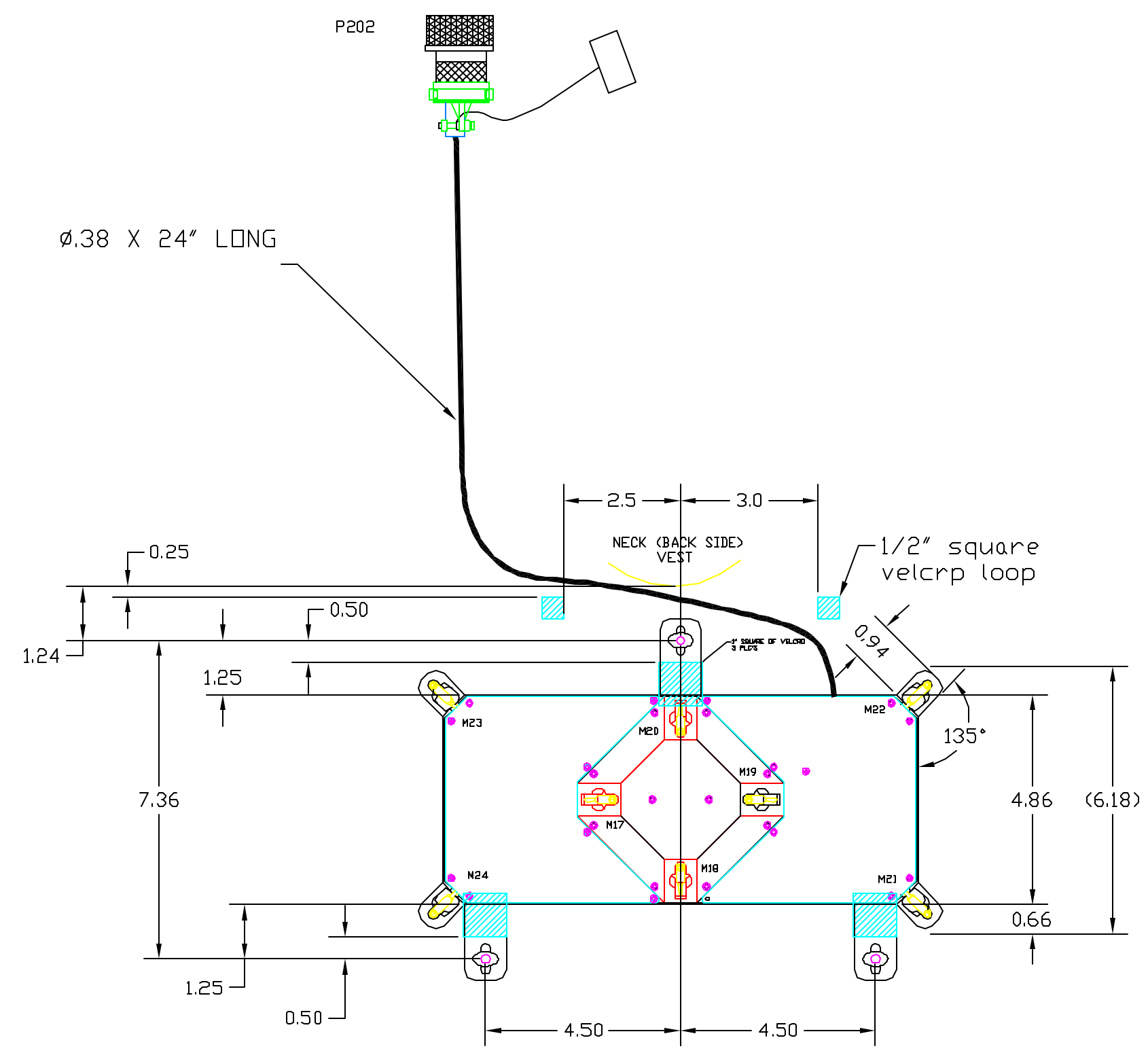
(Outline Drawing not yet available)

6.2.9 Restraint Pole (85-40700)

(Outline Drawing not yet available)

8 7 6 5 4 3 2 1

| REVISIONS | | | | |
|-----------|-----|-------------|------|----------|
| ECO | REV | DESCRIPTION | DATE | APPROVED |
| 85-94 | 01 | PRE-RELEASE | | |



∅.38 X 24" LONG

P202

NECK (BACK SIDE) VEST

1/2" square velcro loop

3 PLECS OF VELCRO

0.94

135°

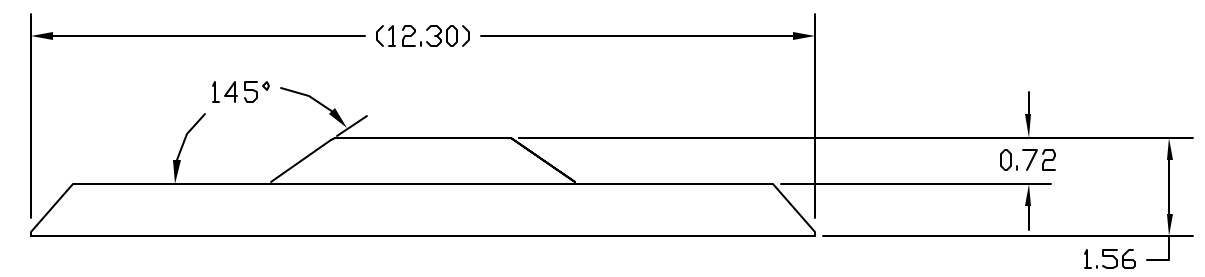
4.86 (6.18)

0.66

4.50

4.50

NOTES:
 1. ALL DIMENSIONS ARE IN INCHES.
 2. CABLE COIL DIAMETER IS 10" X 1' HIGH.



| | | | | | |
|--|-------------------|----------------|-----------|---|----------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA | |
| 85-41000 | VOILA | DRAWN M. SMITH | DATE | BACK MARKER PLATE ICD | |
| NEXT ASSEMBLY | USED ON | CHECKED | APPROVED | SIZE D | FSM# NO. 80230 |
| APPLICATION | WEIGHT = 2.20 LBS | RELEASED | DWG NO. | 85-40900.99 | REV 01 |
| | | | SCALE 1:1 | SHEET 1 OF 1 | |

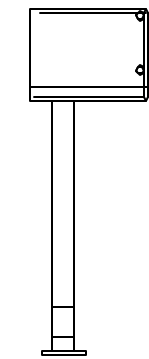
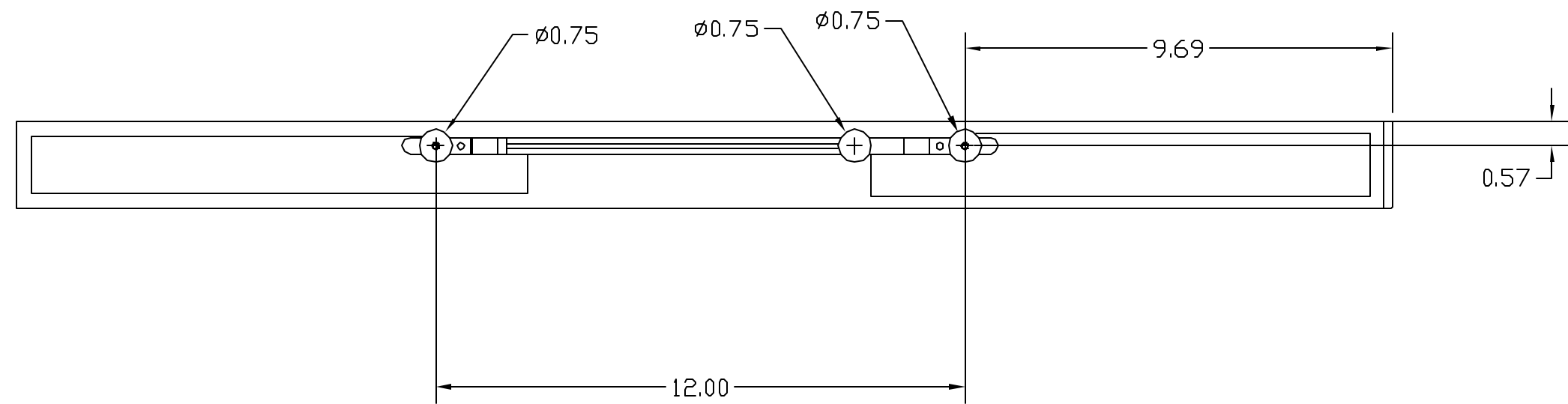
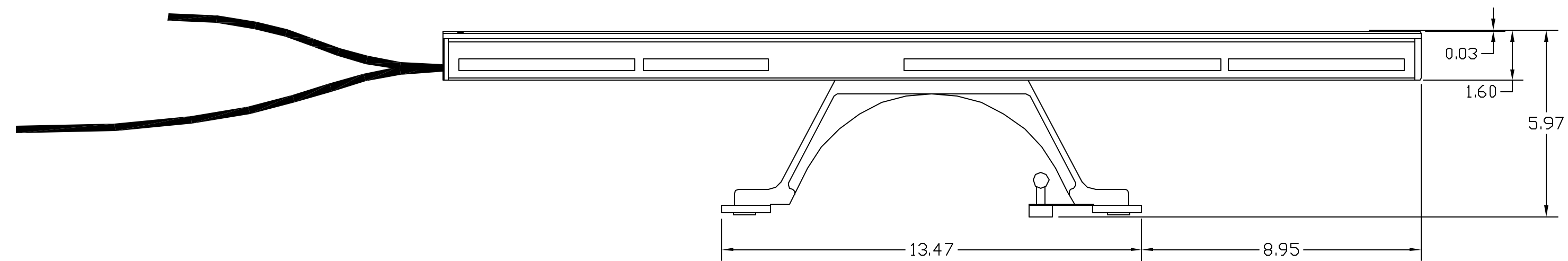
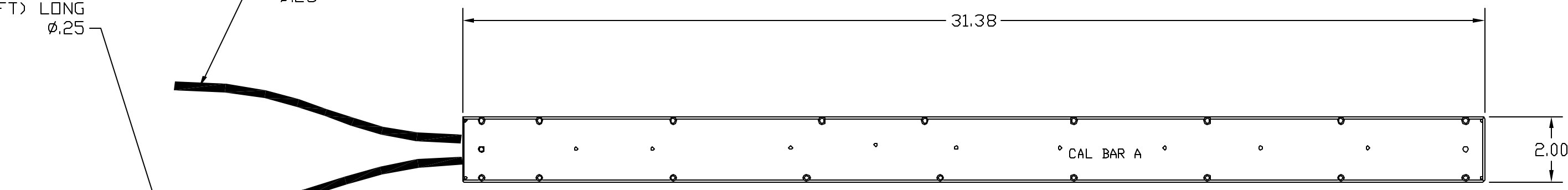
8 7 6 5 4 3 2 1

8 7 6 5 4 3 2 1

| REVISIONS | | | | | |
|-----------|-----|-------------|---------|----------|------|
| ECO | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-94 | 01 | PRE-RELEASE | | | |

TO VOILA EE
216" (18 FT) LONG
Ø.25

TO CAL BAR B
72" (6 FEET) LONG
Ø.25



NOTES.
1. DIMENSIONS ARE IN INCHES.
2. CABLE COIL DIAMETER IS 8" X 1" HIGH.

| | | | | |
|---|---------|-----------|---------------------|---|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA |
| DRAWN M. SMITH | | DATE | | |
| MATERIAL N/A | | CHECKED | | ICD CAL BAR A |
| FINISH N/A | | APPROVED | | |
| 85-41300 | VOILA | RELEASED | | SIZE D 80230 |
| NEXT ASSEMBLY | USED ON | SCALE 1:1 | DWG NO. 85-41300.99 | REV 01 |
| APPLICATION | | CAD FILE | SHEET 1 OF 1 | |

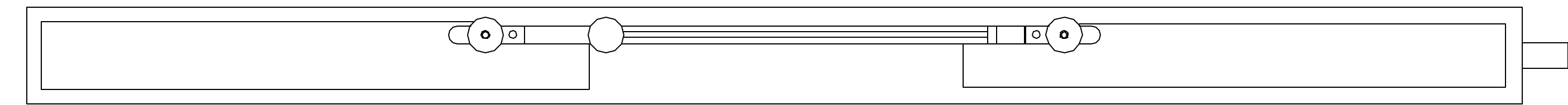
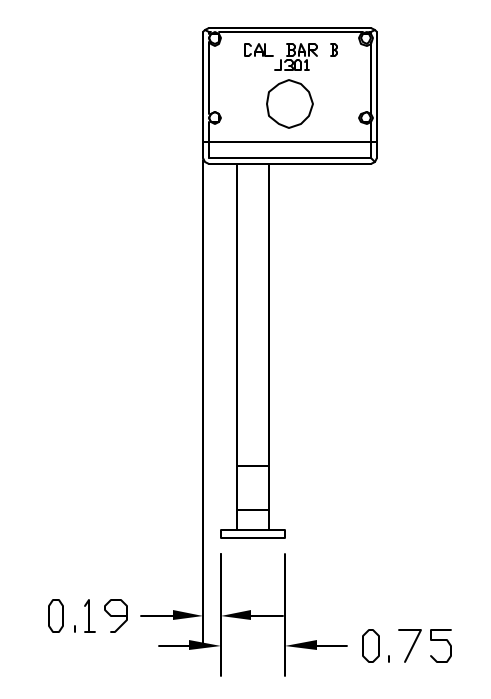
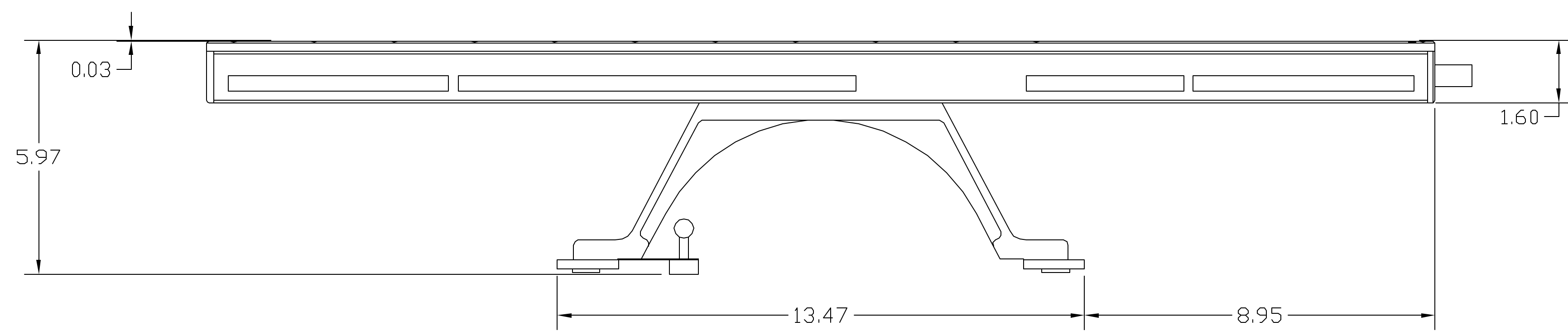
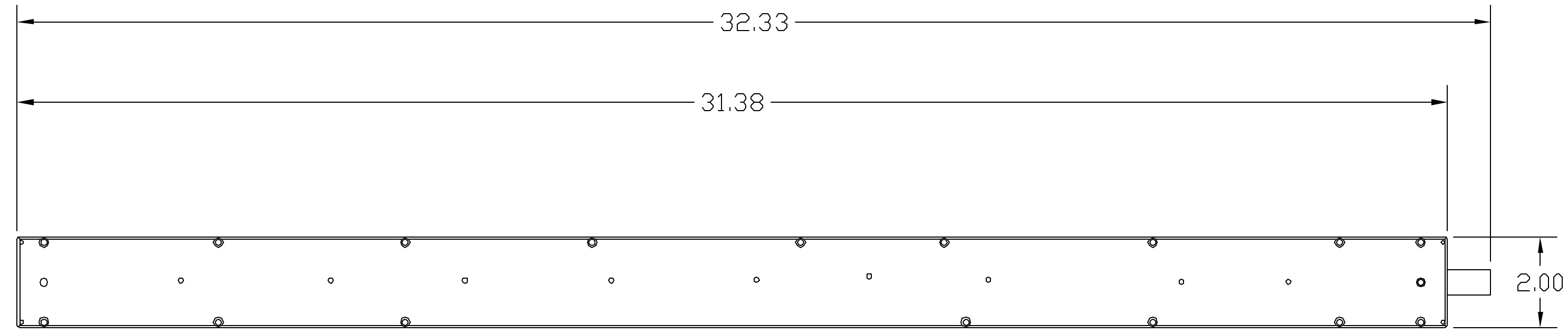
8 7 6 5 4 3 2 1

8 7 6 5 4 3 2 1

| REVISIONS | | | | | |
|-----------|-----|-----------------|---------|----------|------|
| ECO | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-94 | 01 | INITIAL RELEASE | | | |

D
C
B
A

D
C
B
A



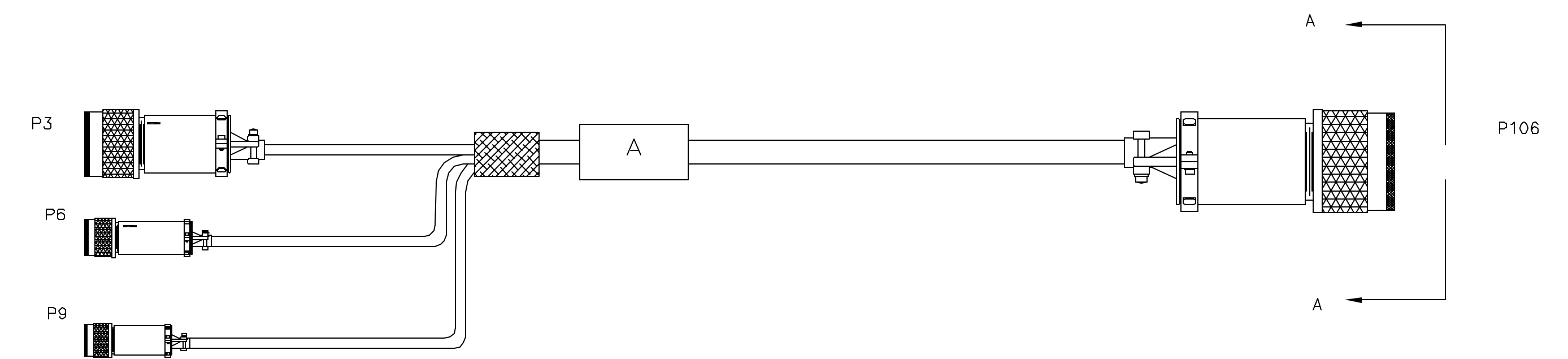
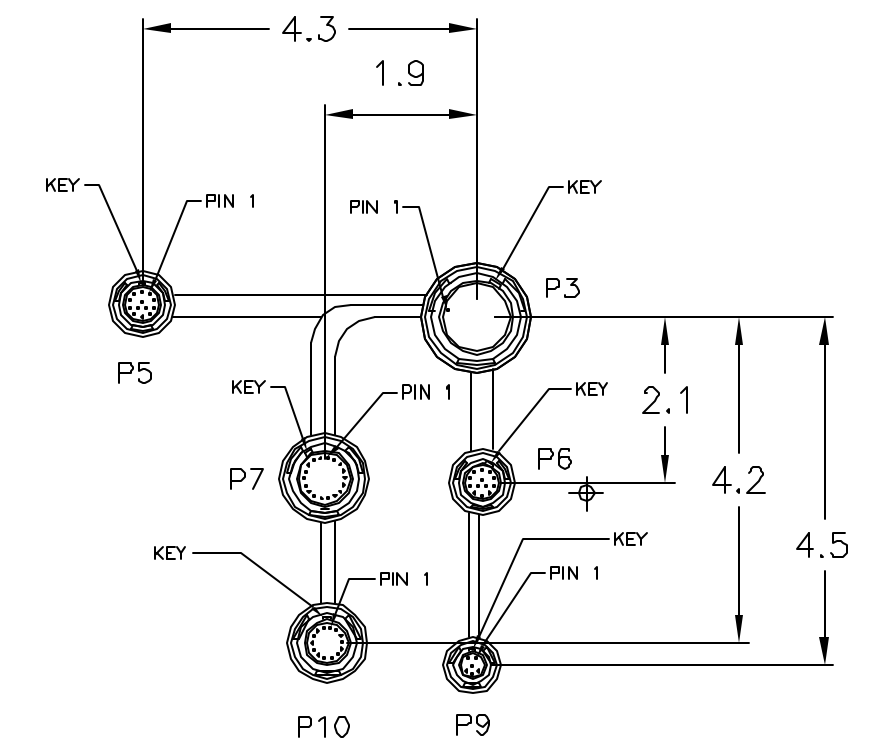
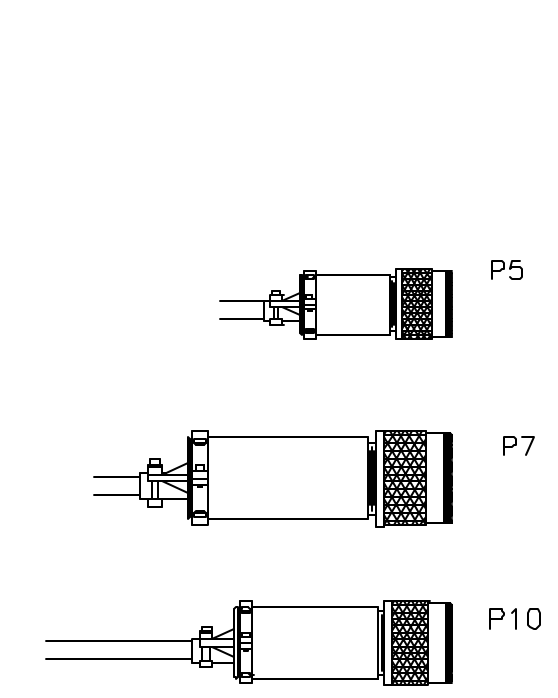
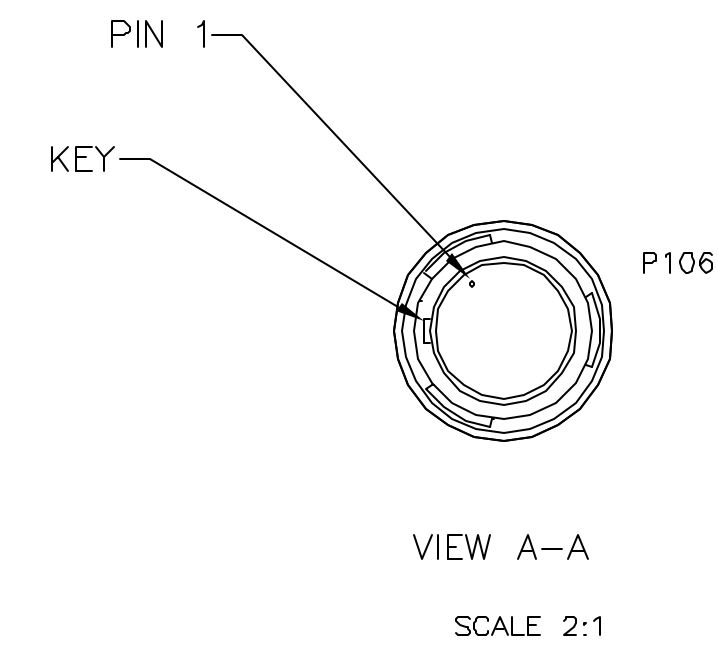
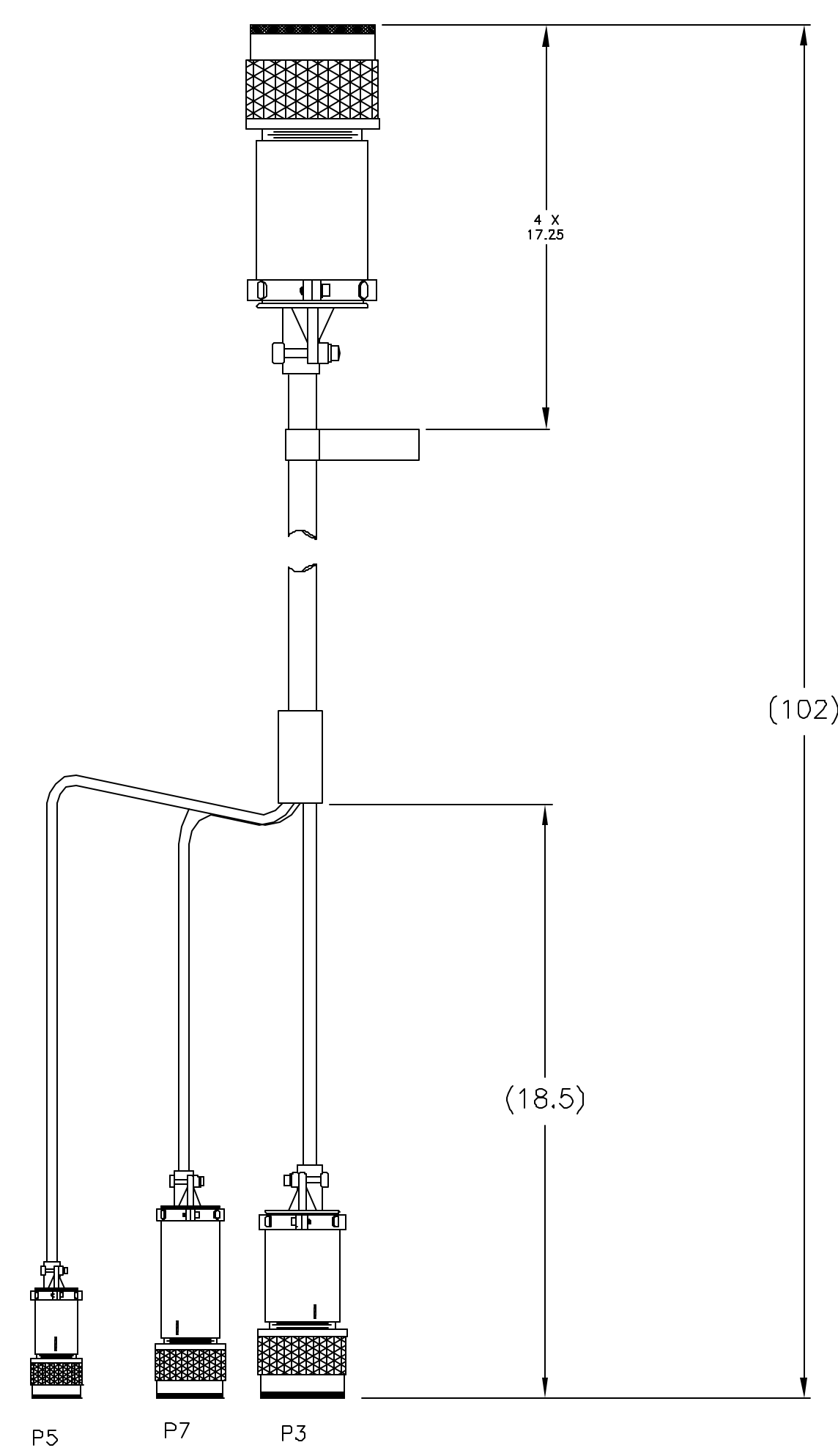
| | | | | | |
|---|---------|----------|------|---|-------------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA | |
| MATERIAL N/A | | DRAWN | | ICD CAL BAR B | |
| FINISH N/A | | CHECKED | | | |
| 85-41400 | VOILA | APPROVED | | SIZE D | FSOM NO. 80230 |
| NEXT ASSEMBLY | USED ON | RELEASED | | DWG NO. 85-41400.99 | REV 01 |
| APPLICATION | | CAD FILE | | SCALE 1:1 | SHEET 1 OF 1 |

6 5 4 3 2 1

| REVISIONS | | | | | |
|-----------|-----|-----------------|---------|----------|------|
| ECO | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-98 | 01 | INITIAL RELEASE | | | |

TABLE A

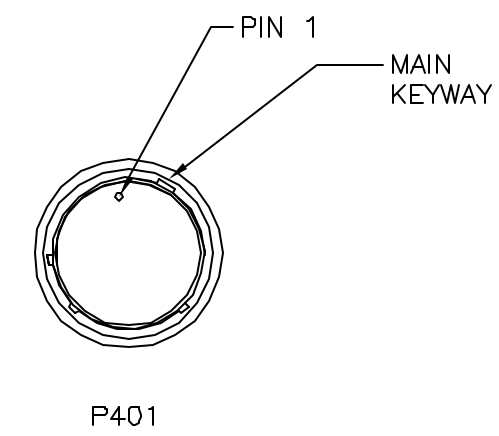
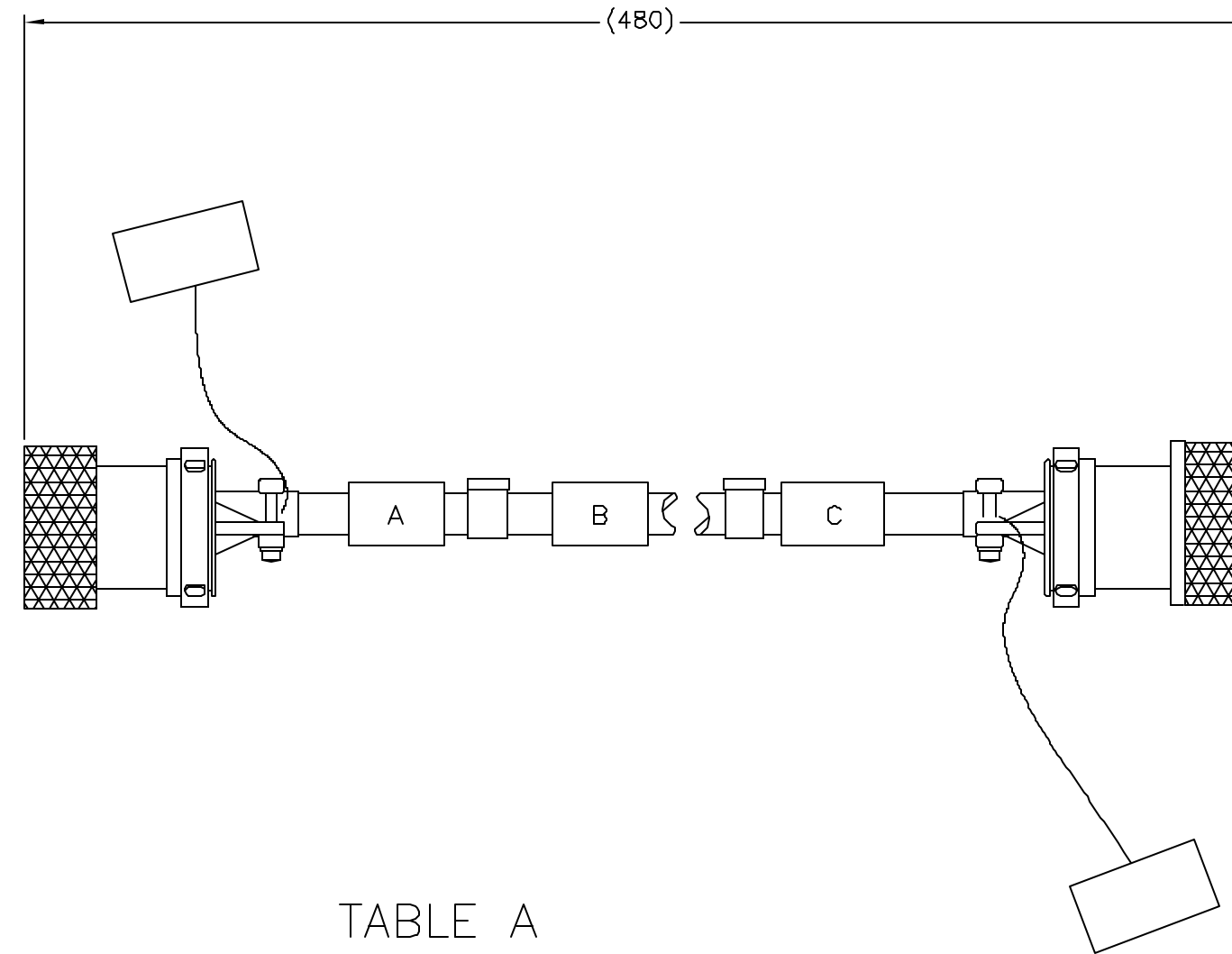
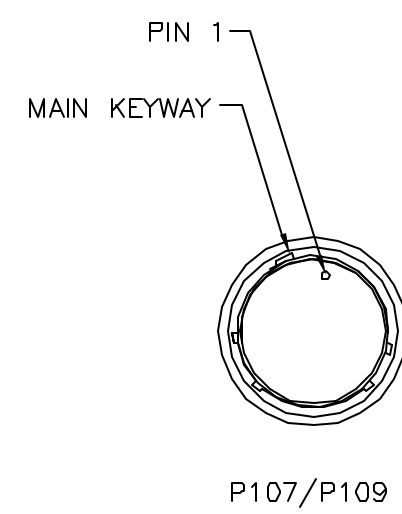
| REF | TEXT |
|------|--|
| P5 | P5 To WS2 NTSC/AUDIO J5 |
| P7 | P7 To WS2 RGB VIDEO J7 |
| P3 | P3 To WS2 A/D, D/A, DIO J3 |
| P6 | P6 To WS2 IRIG-B J6 |
| P9 | P9 To WS2 ETHERNET J9 |
| P10 | P10 To WS2 USB IEEE 1394 J10 |
| P106 | P106 To VOILA EE WS2 J106 |
| A | VOILA WS2 Cable P/N 85-40801 S/N YXX 2 |



- NOTES:
1. COIL DIAMETER IS 16" X 2.0" HIGH.
 2. SERIAL NUMBERS STARTING WITH 100 ARE TRAINING UNITS. SERIAL NUMBERS STARTING WITH 300 ARE FLIGHT UNITS.
 3. COVERS NOT SHOWN FOR CLARITY.

| | | | | | |
|---|---------|----------|---------|---|-------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1° 3 PLACE DECIMALS +/- .003 3 PLACE DECIMALS +/- .01 | | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA | |
| 85-40800 | VOILA | M. SMITH | 4/22/04 | ICD, CABLE WS2 (VOILA EE TO WS2) | |
| NEXT ASSEMBLY | USED ON | CHECKED | | SIZE | D 80230 |
| APPLICATION | | APPROVED | | FSCM NO. | 80230 |
| | | RELEASED | | DWG NO. | 85-40801.99 |
| | | | | SCALE | 1:1 |
| | | | | SHEET | 1 OF 1 |

| REVISIONS | | | | | |
|-----------|-----|-------------|---------|----------|------|
| ZONE | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-98 | 01 | PRE RELEASE | | | |



NOTES:
1. COIL CABLE DIAMTER IS 12" X 1.75" HIGH.

TABLE A

| REF | TEXT |
|-----|--|
| A | P107/P109 To VOILA EE TRACKER BAR J107/J109 |
| B | VOILA Tracker Bar Cable P/N 85-40803 S/N YXX |
| C | P401 To VOILA Tracker Bar TRACKER J401 |

| | | | | | | | | |
|---------------|---------|---|----------|------|---|--|-------------|--------|
| | | UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA PROJECT | | | |
| | | | DRAWN | | | ICD, CABLE, TRACKER BAR (VOILA EE TO TRACKER BAR) | | |
| | | MATERIAL | CHECKED | | | | | |
| | | | APPROVED | | | | | |
| 85-40800 | VOILA | FINISH | RELEASED | | SIZE | FSCM NO. | DWG NO. | REV |
| NEXT ASSEMBLY | USED ON | | | | C | 80230 | 85-40803.99 | 01 |
| APPLICATION | | WEIGHT = 4.0-4.5 LBS. | CAD FILE | | SCALE | 1:1 | SHEET | 1 OF 1 |

| REVISIONS | | | | | |
|-----------|-----|-------------|---------|----------|------|
| ECO | REV | DESCRIPTION | CHECKED | APPROVED | DATE |
| 85-98 | 01 | PRE-RELEASE | | | |
| | | | | | |
| | | | | | |

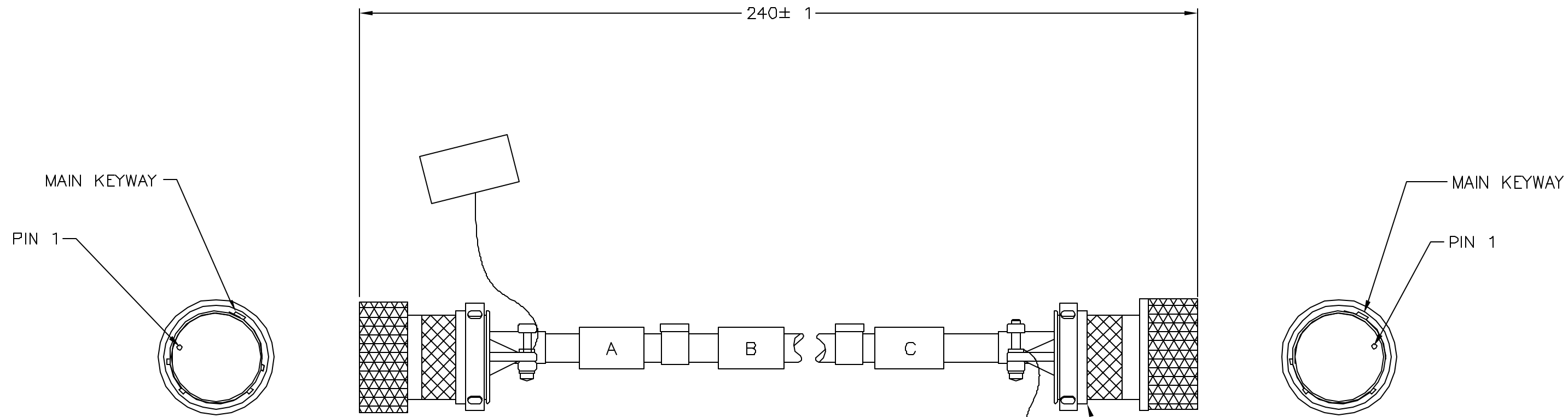


TABLE A

| REF | TEXT |
|-----|--|
| A | P104 To VOILA EE CHESTPACK J104 |
| B | VOILA Chestpack Cable P/N 85-40806 S/N YXX 2 |
| C | P204 To VOILA Chestpack CHESTPACK J204 |

NOTES:

1. COIL DIAMETER IS 12" X 1.75" HIGH.

2 SERIAL NUMBERS STARTING WITH 100 ARE TRAINING UNITS.
SERIAL NUMBERS STARTING WITH 300 ARE FLIGHT UNITS.

| | | | | | | | | | |
|---------------|---------|---|----------|-----------|---|--------------|---------|-----|---------|
| | | UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: ANGLES +/- 1° 3 PLACE DECIMALS +/- .005 2 PLACE DECIMALS +/- .01 | NAME | DATE | Massachusetts Institute of Technology Center for Space Research VOILA PROJECT | | | | |
| | | | DRAWN | M. SMITH | | | | | 4/12/04 |
| | | MATERIAL N/A | CHECKED | | ICD, CABLE CHESTPACK (VOILA EE TO CHESTPACK) | | | | |
| | | | APPROVED | | | | | | |
| | | | RELEASED | | | | | | |
| 85-40800 | VOILA | N/A FINISH | | | SIZE | FSCM NO. | DWG NO. | REV | |
| NEXT ASSEMBLY | USED ON | | C | 80230 | 85-40806.99 | 01 | | | |
| APPLICATION | | WEIGHT: 4.0 - 4.5 LBS | CAD FILE | SCALE 1:1 | | SHEET 1 OF 1 | | | |