SOUTHWEST RESEARCH INSTITUTE

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Department of Applied Electromagnetics

DOCUMENT NO. CS-2
REVISION A

CONFIGURATION SPECIFICATION

FOR THE

M172 BODY MASS MEASUREMENT DEVICE

FLIGHT HARDWARE

PRELIMINARY - NASA APPROVAL PENDING

PREFACE

This Configuration Specification documents the design approach, detail design, qualification status and configuration status of Experiment M172, Body Mass Measurement Device, Flight Hardware that will be presented by Southwest Research Institute at the Critical Design Review.

This specification is based upon the technical requirements presented in Section 3.0 of document MSC-KW-E-69-11, Revision B., End Item Specification, Flight Hardware for Body Mass Measurement (Experiment M172), dated 12 October 1970.

1.0 DESIGN APPROACH

1.1 Applicable Documents

The following documents, of the exact issue shown, form a part of the design approach of this configuration specification to the extent specified herein. In the event of a conflict between the documents referenced here and the other detail contents of paragraphs 1.2 and 1.3, the detail content of paragraphs 1.2 and 1.3 shall be considered a superseding requirement.

1.1.1 Specifications

1.1.1.1 Southwest Research Institute

MSC-KW-E-69-11 Revision B 12 October 1970	End Item Specification Flight Hardware for Body Mass Measurement (Experiment M172)

1.1.2 Other Documents

1.1.2.1 NASA

13M12101 January 1970	M172 Body Mass Measurement Mechanical Requirements (CCBD No. OT0090/6-4-70)
40M35644 17 April 1970	M172 Body Mass Measurement Device/OWS Electrical Interface (CCBD No. OT0078/5-25-70)
MSC-KW-D-69-12 Revision A 10 July 1970	Experiment Requirements Documents for Body Mass Measurement (Experiment M172)

1.1.2.2 Southwest Research Institute

GSEDS-2 17 July 1970	GSE Data Sheet for the M172 Body Mass Measurement Device Leveling Fixture

1.2 General Description of BMMD

The BMMD comprises a mechanical subsystem and an electronics subsystem. This device is completely self-contained with the exception of requiring a nominal 28 volt dc power source and a plane, stable mounting surface. The device is designed to measure the mass of human subjects up to a weight of 100 kilograms in a one "g" and in a zero "g" environment.

To operate the device, the subject to be measured lowers himself into the seat and fastens the body restraint straps. The "mass/off/temp" switch of the electronics subsystem is put in the "mass" position, and the digital display is cleared by actuating the reset switch. A control lever is then pushed forward to unlock the seat. The subject tenses his muscles, holds his breath (breath will be held for about ten seconds) then releases a sear, and the seat begins to oscillate.

An electro-optical transducer sends a signal to the device's logic circuit each time the seat crosses the equivalent midpoint in its oscillating cycle. After two cycles have been completed, the total elapsed time for the next three cycles, to tens of microseconds, appears on the device's digital display. The device is shut down by actuating the control lever, which moves the seat to the offset position, latches the sear, and finally locks the seat. The period reading, shown on the digital display, is recorded manually. The "mass/off/temp" switch is put in the "temp" position, the reset switch is actuated, and the temperature, shown on the digital display, is recorded manually. The electronics is then de-energized. The recorded readings (i. e. temperature and period of oscillation) are used to obtain mass values by reference to a calibration curve, conversion chart, or equation.

In a one "g" environment, the BMMD must be set up on a fixture that will allow careful leveling so as to minimize the effect of gravity. The leveling fixture shall be Ground Support Equipment and is described by document GSEDS-2.

Flight articles covering a range of approximately 50-100 kilograms shall serve as calibration masses and a calibration card shall be provided to assure proper calibration of the BMMD.

Sketch numbers SK-283706, Body Mass Measurement Device, Preliminary Layout, and SK-283707, Leveling Fixture - BMMD, Preliminary, illustrate the general features of the Body Mass Measurement Device and are presented as Figure 1.2-1 and 1.2-2, respectively.

1.2.1 Mechanical Subsystem

The main components of the mechanical subsystem are the frame, springs, seat, seat lock, restraint system, and sear

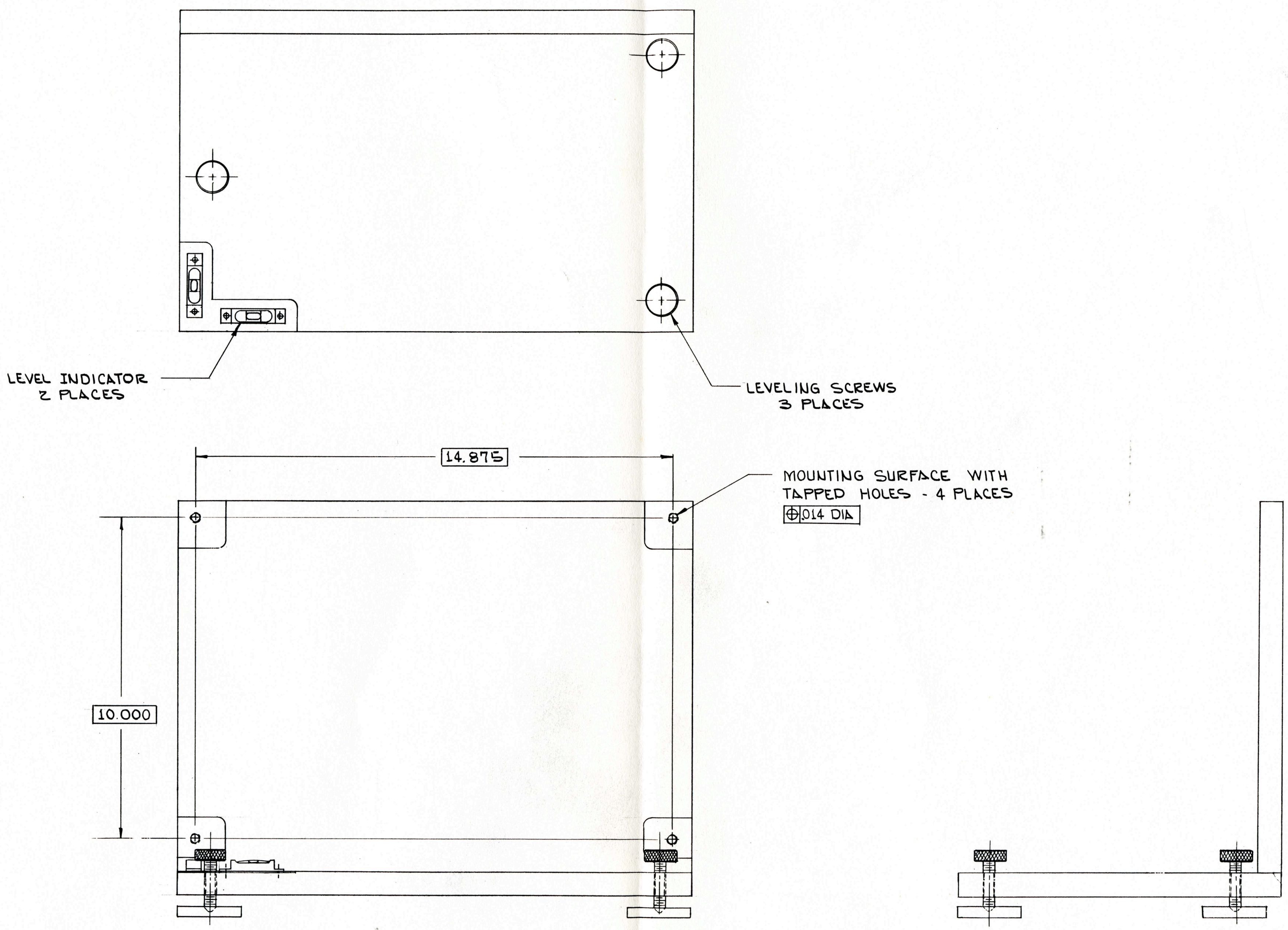


FIGURE 1.2-1

BMMD, Preliminary Layout

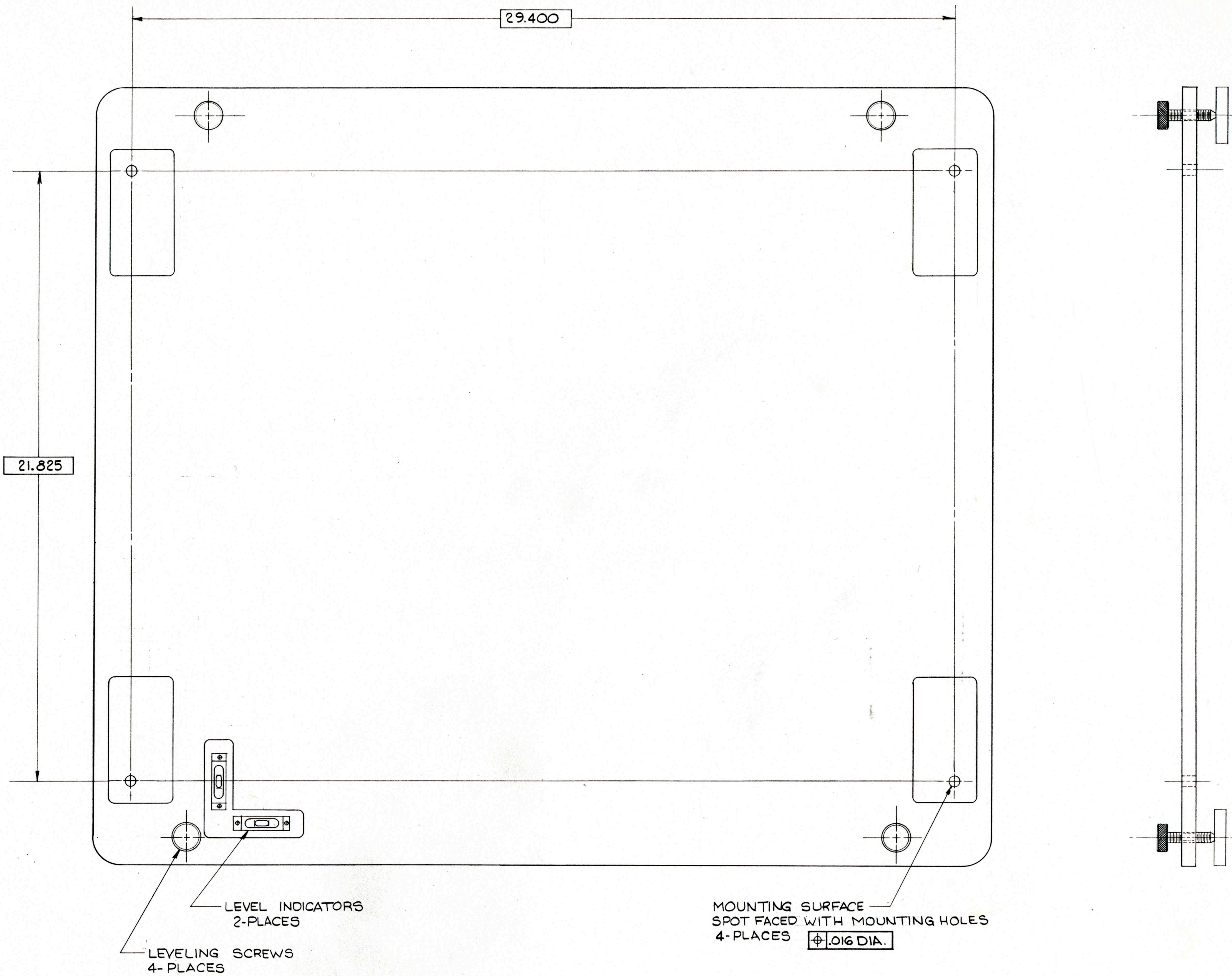


FIGURE 1.2-2

Leveling Fixture - BMMD, Preliminary

mechanism.

The frame forms the structure of the device, and the seat is suspended from the frame by means of the springs. When the device is not in use, the seat is locked to the frame by the seat lock. Protection to the springs is provided in the locked configuration because the mass of the seat is no longer suspended on the springs; therefore, forces accidentally applied to the seat are not transmitted to the springs.

The springs are plate-fulcra type and consist of a pair of identical flat plates, one at each end of the frame. One end of each spring is rigidly attached to the frame, and the other end of each spring is rigidly attached to the seat, one at the front and the other at the rear. This arrangement suspends the seat from the frame on the springs and allows relative motion between the seat and frame during the measurement cycles.

The restraint system consists of body restraint straps which couple the seat and the subject whose mass is to be measured. After the subject lowers himself into the seat, these restraint straps are fastened around his body and attached to the seat. This couples the subject to the seat, preventing relative motion during the measurement cycles.

The sear mechanism serves to hold the seat an exact distance from its neutral position in preparation for the measurement cycles. In this position, the springs are also offset. In operation, a control lever is first used to unlock the seat. When the subject is ready for mass measurement, he releases the sear, and the restoring force of the springs causes the seat to oscillate. After the mass measurement is completed, the control lever is actuated in the reverse direction. This moves the seat and springs to the offset position, latches the sear, and locks the seat.

1.2.2 Electronics Subsystem

The electronics subsystem consists of five separate functional components. These components are the power regulator, the temperature sensor, the electro-optical transducer, the clock and digital logic, and the digital display. Figure 1.2.2-1 is a block diagram of the electronics subsystem.

The five components are encapsulated into a single module. The BMMD electronics subsystem module is identical to that

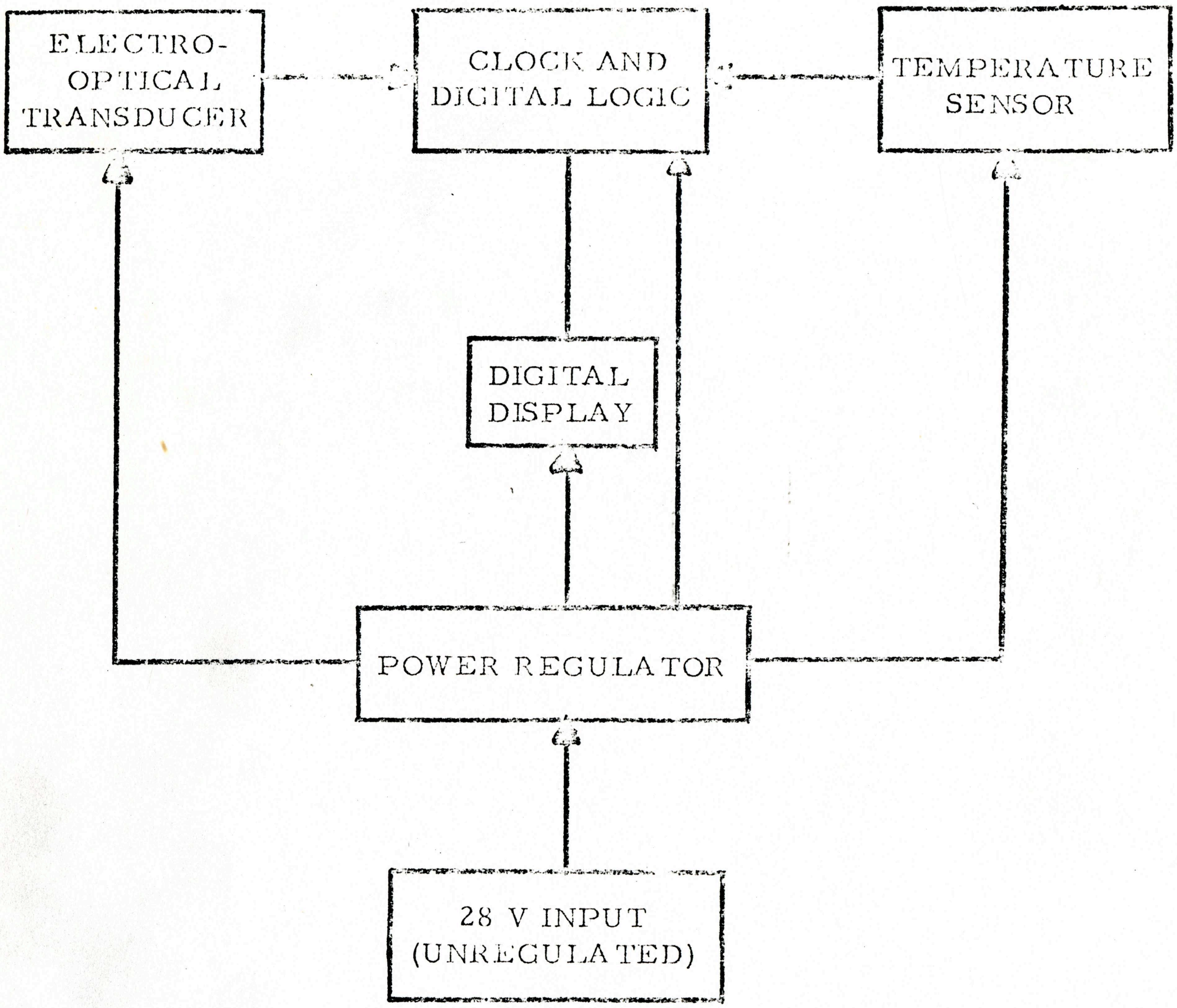


FIGURE 1.2.2-1 - ELECTRONICS SUBSYSTEM BLOCK DIAGRAM

of the SMMD (Experiment M074). These two modules are designed to be interchangeable in flight. Following is a brief description of each component of the electronics subsystem:

a. Power Regulator

Voltage regulation of the spacecraft-supplied power is accomplished by a "switching" regulator, which provided maximum efficiency in voltage regulation. Pulse current is supplied to a storage element as required to maintain the desired +5 volts dc output. A balanced filter is incorporated in the input section to reduce conducted EMI on the input lines and to provide protection against transients from the spacecraft source.

The power regulator supplies power necessary to operate the electronics subsystem and derives its power from the unregulated power supply of the spacecraft.

b. Electro-Optical Transducer

The electro-optical transducer component senses the equilibrium position of the seat. The first two periods of oscillation are ignored in order to allow any transients produced by the release mechanism to dissipate. The beginning of the third period signals a start-count to the clock and digital logic component, and the beginning of the sixth period signals a stop-count to the clock and digital logic component.

The light emitter consists of a solid state light emitting source in the 900 nm wavelength range, while the sensor consists of a solid state sensing device. The electro-optical transducer operates on power furnished by the power regulator.

c. Temperature Sensor

The temperature is sensed by a thermistor probe. The probe determines the "on time" of an integrated monostable multivibrator, which in turn controls the input to the clock and digital logic component. Temperature is displayed to the nearest degree by two of the six digits in the digital display. Accuracy is $+1^{o}$F between 65^{o}F and 80^{o}F. The temperature is displayed continuously when the function switch is in the "Temp" position and may be updated by depressing the "Reset" switch. The temperature sensor operates on power furnished by the power regulator.

d. Clock and Digital Logic

The clock and digital logic component consists of a 1 MHz oscillator, seven integrated circuit up/down decade counters, and six BCD to 7-Bar Converters. The control logic necessary to perform the functions for mass and temperature measurements is also contained in the clock and digital component.

When measuring mass, the counter will "count up", and the period of 3 seat oscillations is displayed on the digital display component.

As the thermistor has a negative temperature coefficient, the counter will "count down" from a pre-set number when measuring temperature, and the temperature can be read directly from the digital display.

The clock and digital logic component operates on power furnished by the power regulator.

e. Digital Display

The digital display component is composed of six 7-bar light emitting diode numerical displays. The signals processed by the clock and digital logic component are displayed in digital form by the digital display component.

The digital display component operates on power provided by the power regulator.

1.3 Interface Control

1.3.1 Mechanical Interfaces

The mechanical interface control document for the M172 Experiment is document No. 13M12101.

1.3.2 Electrical Interfaces

The electrical interface control document for the M172 Experiment is document No. 40M35644.

1.3.3 Flight Crew Interfaces

The flight crew interfaces for the M172 Experiment are identified in Section 6.0 of MSC-KW-D-69-12.

1.3.4 Ground Support Equipment Interfaces

An adjustable platform provided with the BMMD and capable of being leveled, per document GSEDS-2, is required for pre-installation checkout of the BMMD.

2.0 DETAIL DESIGN

2.1 Applicable Documents

The following documents, of the exact issue shown, form a part of the detail design of this configuration specification to the extent specified herein. In the event of a conflict between the documents referenced here and the other detail contents of paragraphs 2.2 through 2.5, the detail content of paragraphs 2.2 through 2.5 shall be considered a superseding requirement.

2.1.1 Specifications

2.1.1.1 Southwest Research Institute

MSC-KW-E-69-11 Revision B 12 October 1970	End Item Specification Flight Hardware for Body Mass Measurement (Experiment M172)

2.1.2 Other Documents

2.1.2.1 NASA

13M12101 January 1970	M172 Body Mass Measurement Mechanical Requirements (CCBD No. OT0090/6-4-70)
40M35644 17 April 1970	M172 Body Mass Measurement Device/OWS Electrical Interface. (CCBD No. OT0078/5-25-70)
MSC-KW-D-69-12 Revision A 10 July 1970	Experiment Requirements Document for Body Mass Measurement (Experiment M172)

2.1.2.2 Southwest Research Institute

GSEDS-2 17 July 1970	GSE Data Sheet for the M172 Body Mass Measurement Device Leveling Fixture

2.2 General Description

This Detail Design is based upon the approved Design Approach contained in Section 1.0 of this document and upon the requirements of Section 3.0 of MSC-KW-E-69-11. The Detail Design presented herein will be studied during the Critical Design Review and, with any modifications determined to be necessary, will be approved and become the baseline configuration for the manufacture of the hardware. With the exception of minor drawing changes, the baseline configuration will be changed only through the approval of Engineering Change Proposals/Specification Change Notices. Minor drawing changes are defined as changes which could not adversely affect safety, reliability, quality, durability, performance, interchangeability of parts or assemblies, weight, development schedule or contract cost. Minor drawing changes may be implemented without the submittal of Engineering Change Proposals/Specification Change Notices until the first Acceptance Tests are started. All minor drawing changes will be evaluated and approved, prior to implementation, by the Configuration Control Manager, and each change approved as a minor drawing change will be clearly indicated as such.

The BMMD comprises a mechanical subsystem and an electronics subsystem. This device is completely self-contained with the exception of requiring a nominal 28 volt dc power source and a plane, stable mounting surface. The device is designed to measure the mass of human subjects up to a weight of 100 kilograms in a one "g" or in a zero "g" environment. The approximate weight of the BMMD is 75 pounds.

To operate the device, the subject to be measured lowers himself into the seat and fastens the body restraint straps. The "mass/off/temp" switch of the electronics subsystem is put in the "mass" position, and the digital display is cleared by actuating the reset switch. A control lever is then pushed forward to unlock the seat. The subject tenses his muscles, holds his breath (breath will be held for about ten seconds) then releases a sear and the seat begins to oscillate.

An electro-optical transducer sends a signal to the device's logic circuit each time the seat crosses the equivalent midpoint in its oscillating cycle. After two cycles have been completed, the total elapsed time for the next three cycles, in tens of microseconds, appears on the device's digital display. The device is shut down by actuating the control lever, which moves the seat to the offset position, latches the sear, and finally locks the seat. The period reading, shown on the digital display, is recorded. The "mass/off/temp" switch is put in the "temp" position, the reset switch is actuated, and the temperature, shown on the digital display, is recorded. The electronics is then de-energized. The recorded readings (i.e. temperature and period of oscillation) are used to obtain mass values by reference to a calibration curve, conversion chart, or equation.

In a one "g" environment, the BMMD must be set up on a fixture that will allow careful leveling so as to minimize the effect of gravity. The leveling fixture shall be Ground Support Equipment and is described by document GSEDS-2.

Flight articles covering a range of approximately 50-100 kilograms shall serve as calibration masses and a calibration card shall be provided to assure proper calibration of the BMMD.

2.2.1 Mechanical Subsystem

The main components of the mechanical subsystem are the frame, springs, seat, seat lock, restraint system and sear mechanism.

The frame forms the structure of the device, and the seat is suspended from the frame by means of the springs. When the device is not in use, the seat is locked to the frame by the seat lock. Protection to the springs is provided in the locked configuration because the mass of the seat is no longer suspended on the springs; therefore, forces accidentally applied to the seat are not transmitted to the springs.

The springs are plate-fulcra type anc consist of a pair of identical flat plates, one at each end of the frame. One end of each spring is rigidly attached to the frame and the other end of each spring is rigidly attached to the seat, one at the front and the other at the rear. This arrangement suspends the seat from the frame on the springs and allows relative motion between the seat and frame during the measurement cycles.

The restraint system consists of body restraint straps which couple the seat and the subject whose mass is to be measured. After the subject lowers himself into the seat, these restraint straps are fastened around his body and attached to the seat. This couples the subject to the seat, preventing relative motion during the measurement cycles.

The sear mechanism serves to hold the seat an exact distance from its neutral position in preparation for the measurement cycles. In this position, the springs are also offset. In operation, a control lever is first used to unlock the seat. When the subject is ready for mass measurement, he releases the sear and the restoring force of the springs causes the seat to oscillate. After the mass measurement is completed, the control lever is actuated in the reverse direction. This moves the seat and springs to the offset position, latches the sear, and locks the seat.

2.2.2 Electronics Subsystem

The electronics subsystem consists of five separate functional components. These components are the power regulator, the temperature sensor, the electro-optical transducer, the clock and digital logic, and the digital display. Figure 2.2.2-1 is a block diagram of the electronics subsystem.

The five components are encapsulated into a single module. The BMMD electronics subsystem module is identical to that of the SMMD (Experiment M074). These two modules are designed to be interchangeable in flight. Following is a brief description of each component:

a. Power Regulator

Voltage regulation of the spacecraft-supplied power is accomplished by a "switching" regulator, which provides maximum efficiency in voltage regulation. Pulse current is supplied to a storage element as required to maintain the desired +5 volts dc output. A balanced filter is incorporated in the input section to reduce conducted EMI on the input lines and to provide protection against transients from the spacecraft source.

The power regulator supplies power necessary to operate the electronics subsystem and derives its power from the unregulated power supply of the spacecraft.

b. Electro-Optical Transducer

The electro-optical transducer component senses the equilibrium position of the seat. The first two periods of oscillation are ignored in order to allow any transients produced by the release mechanism to dissipate. The beginning of the third period signals a

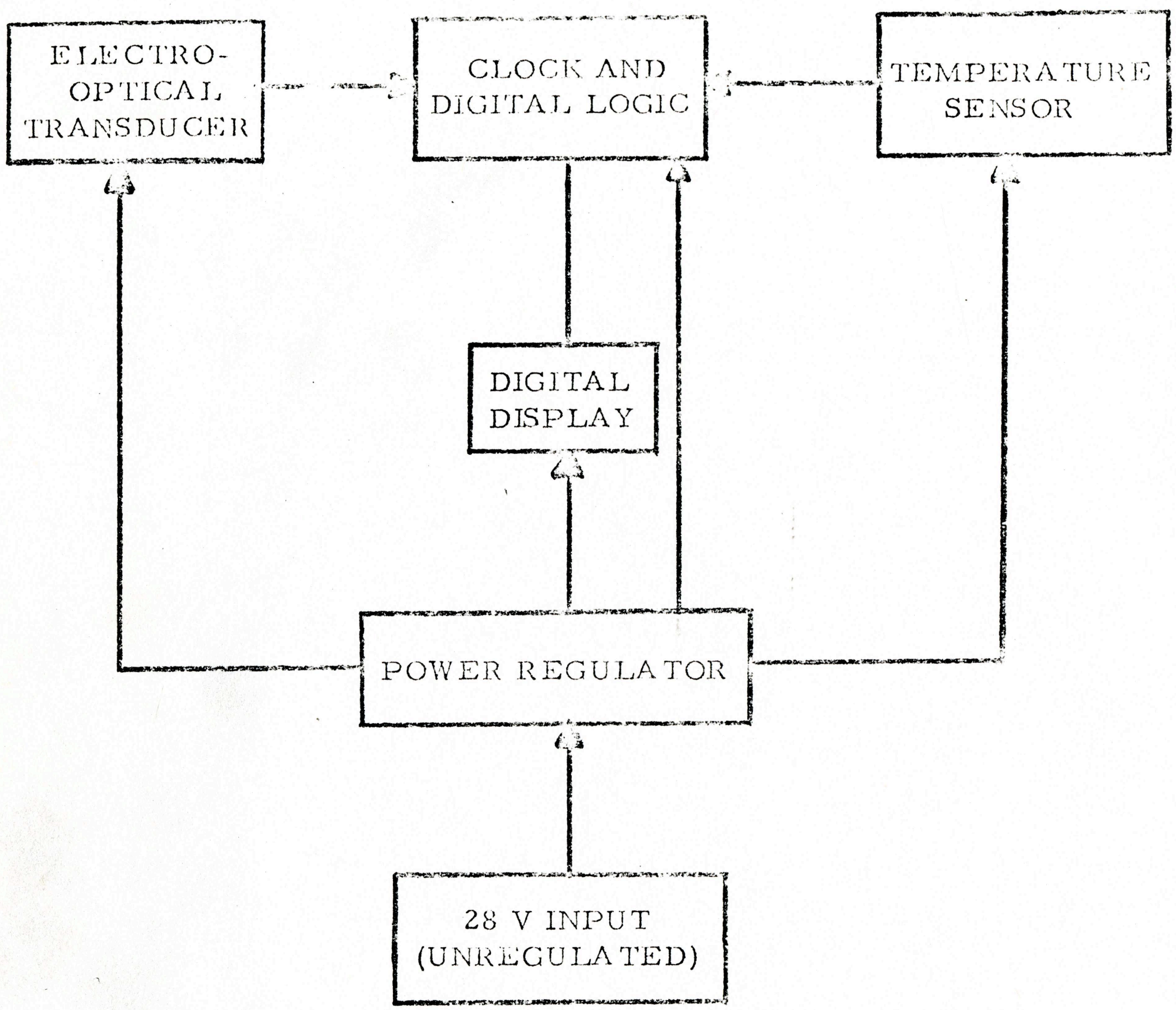


FIGURE 2.2.2-1 - ELECTRONICS SUBSYSTEM BLOCK DIAGRAM

start-count to the clock and digital logic component, and the beginning of the sixth period signals a stop-count to the clock and digital logic component.

The light emitter consists of a solid state light emitting source in the 900 nm wavelength range, while the sensor consists of a solid state sensing device. The electro-optical transducer operates on power furnished by the power regulator.

c. Temperature Sensor

The temperature is sensed by a thermistor probe. The probe determines the "on time" of an integrated monostable multivibrator, which in turn controls the input to the clock and digital logic component. Temperature is displayed to the nearest degree by two of the six digits in the digital display. Accuracy is $\pm 1^{o}$F between 65^{o}F and 80^{o}F. The temperature is displayed continuously when the function switch is in the "Temp" position and may be updated by depressing the "Reset" switch. The temperature sensor operates on power furnished by the power regulator.

d. Clock and Digital Logic

The clock and digital logic component consists of a 1 MHz oscillator, seven integrated circuit up/down decade counters, and six BCD to 7-Bar Converters. The control logic necessary to perform the functions for mass and temperature measurements is also contained in the clock and digital logic component.

When measuring mass, the counter will "count up", and the period of 3 seat oscillations is displayed on the digital display component.

As the thermistor has a negative temperature coefficient, the counter will "count down" from a pre-set number when measuring temperature, and the temperature can be read directly from the digital display.

The clock and digital logic component operates on power furnished by the power regulator.

e. Digital Display

The digital display component is composed of six 7-bar light emitting diode numerical displays. The signals processed by the clock and digital logic component are displayed in digital form by the digital display component.

The digital display component operates on power provided by the power regulator.

2.3 Engineering Drawings and Data

The BMMD top assembly drawing No. 2837-001-01 is presented as Figure 2.3-1. Drawing No. 2837-100-01 of the mechanical subsystem is presented as Figure 2.3-2. Drawing No. 2837-700-01 of the electronics subsystem is presented as Figure 2.3-3. These drawings contain the part numbers of all subsystems and major assemblies which comprise the top assembly; all engineering drawings and engineering data assembled by these drawings are a part of this configuration specification.

2.4 Performance Characteristics

2.4.1 Mechanical Subsystem

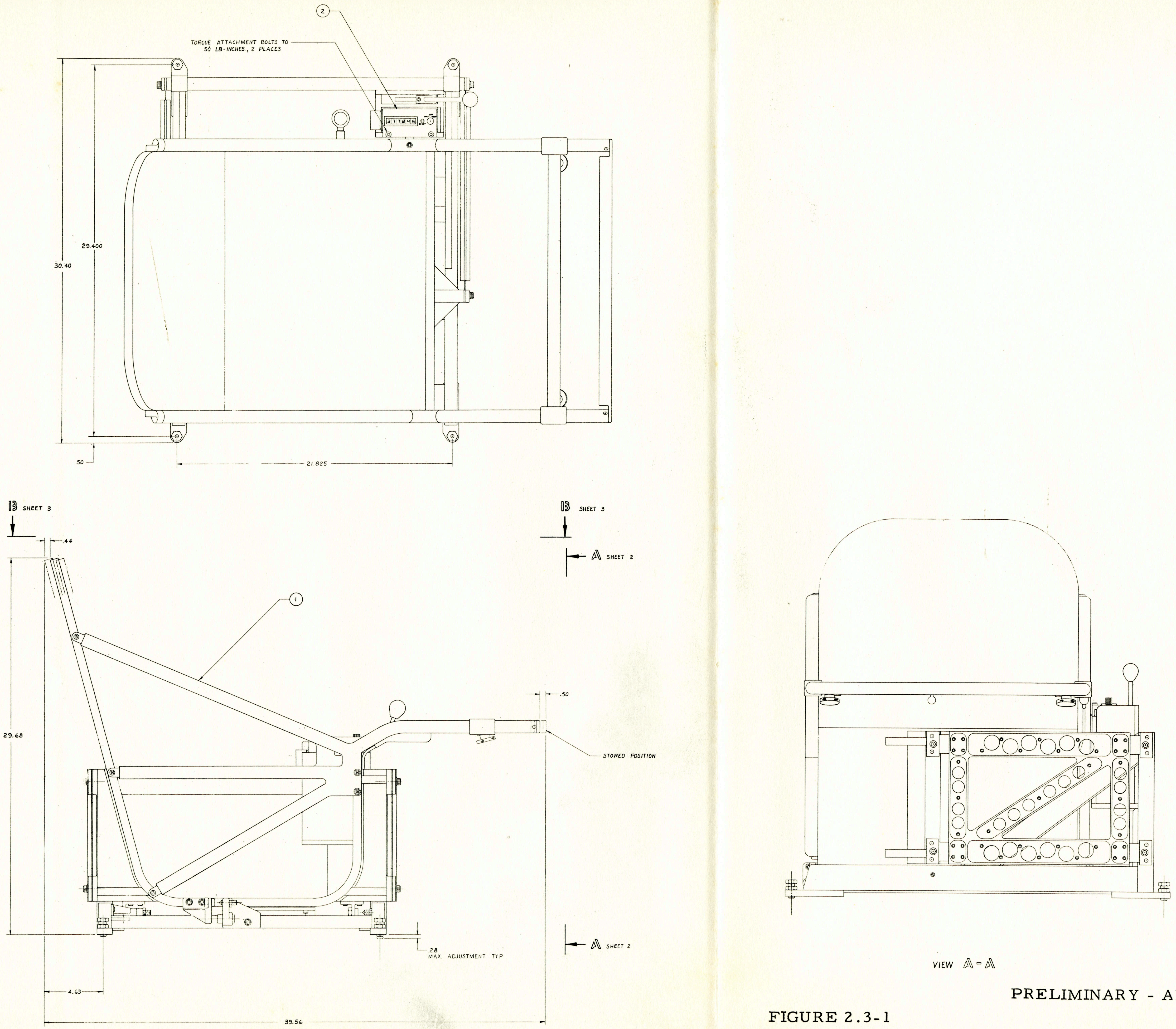
Figure 2.4.1-1 is a block diagram of the BMMD mechanical subsystem. The functional characteristics of each component of the mechanical subsystem are as follows:

1.) The BMMD frame forms the structure of the device from which the seat is suspended.

2.) The subject to be measured assumes a sitting position in the seat for mass measurement.

3.) The body restraint straps serve to couple the seat and the subject whose mass is to be measured. The restraint straps are the quick-release type.

4.) The seat lock is a mechanical device which locks the seat in the offset position. Actuation of the seat lock is performed by the control lever. The seat lock, when in the locked configuration, provides protection to the springs because the mass of the seat is no longer suspended on the springs, and forces accidentally applied to the seat are not transmitted to the springs.



PRELIMINARY - APPROVAL PENDING

FIGURE 2.3-1

Top Assembly of BMMD System

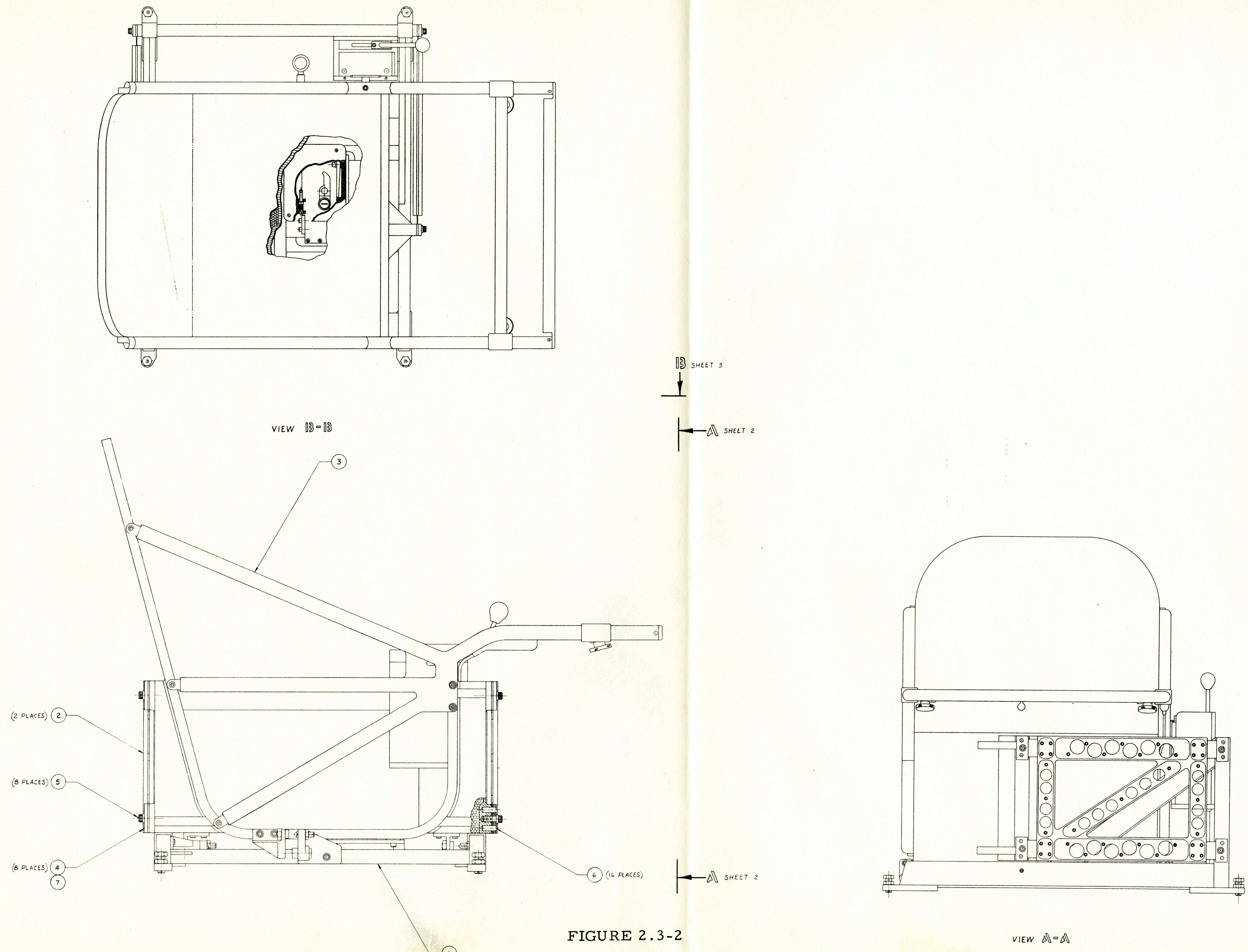
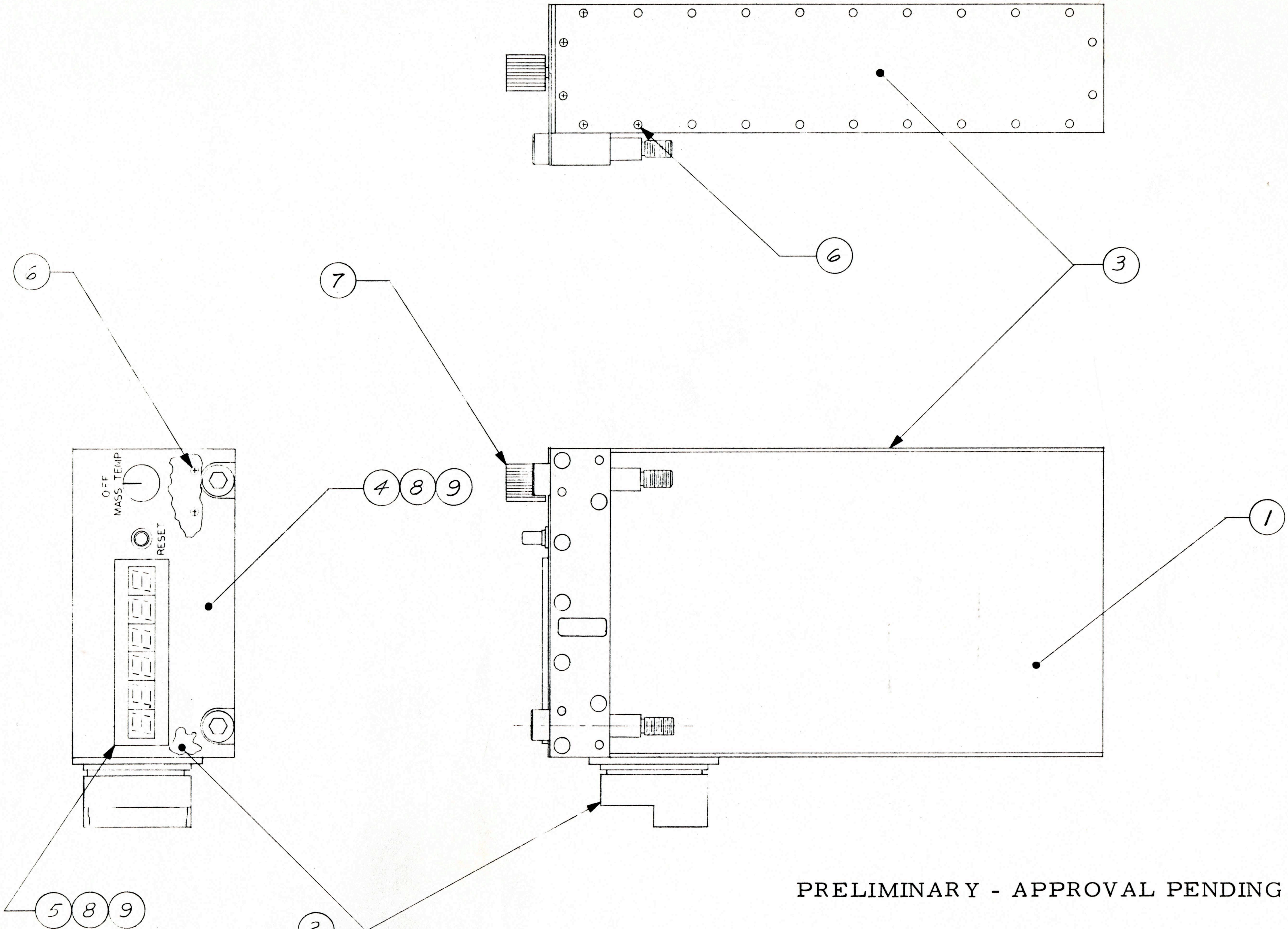


FIGURE 2.3-2

BMMD Mechanical Subsystem

PRELIMINARY - APPROVAL PENDING



PRELIMINARY - APPROVAL PENDING

FIGURE 2.3-3

MMD Electronics Subsystem

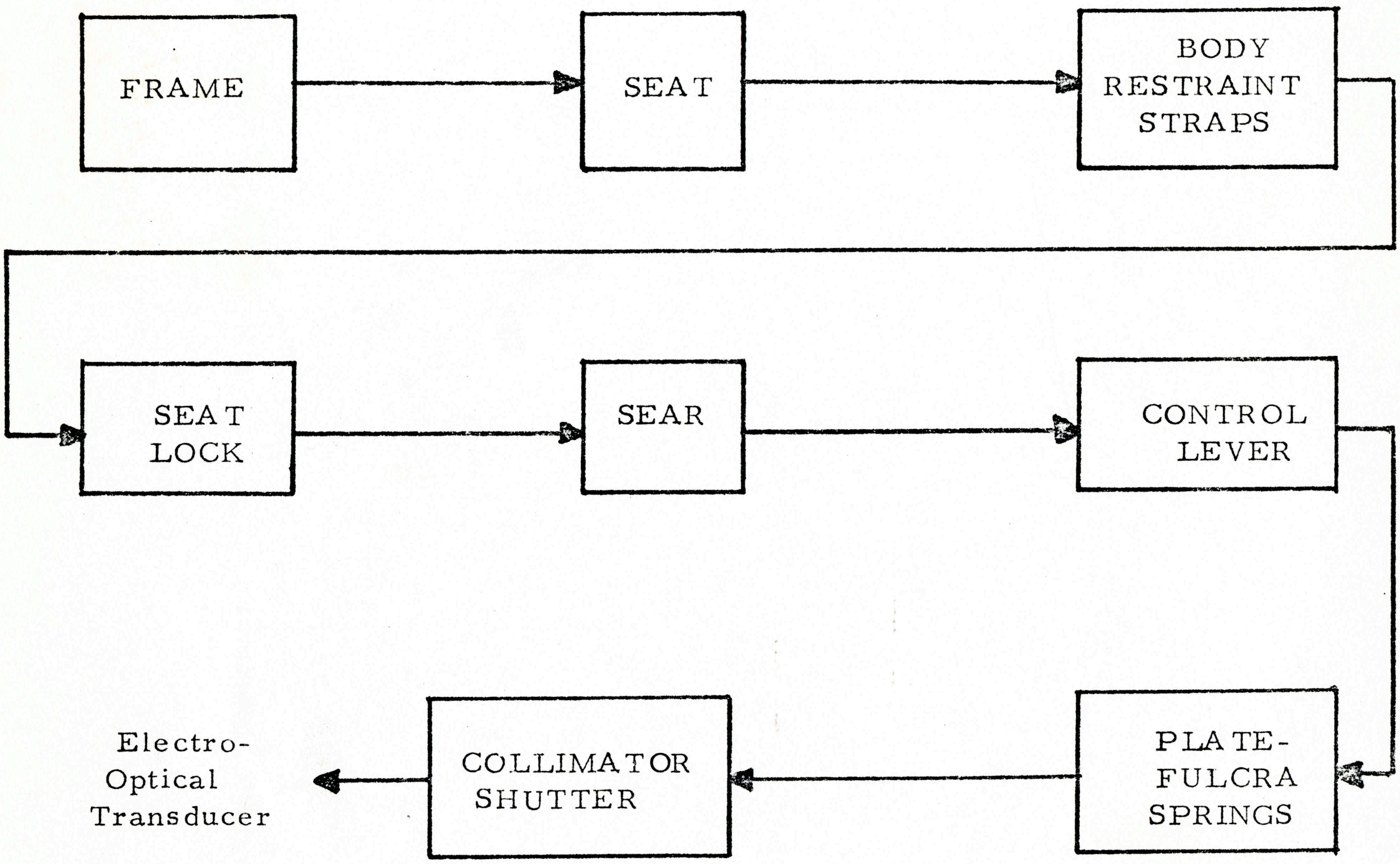


FIGURE 2.4.1-1 - BLOCK DIAGRAM OF BMMD MECHANICAL SUBSYSTEM

5.) The sear serves to hold the seat an exact distance from its neutral position in preparation for measurement. The sear may be released by either of two techniques. The first is the "seat release" in which the subject to be measured manually releases the sear after first unlocking the seat by control lever actuation. The second technique is "frame release" which is utilized in calibration measurements. In this release mode, the release mechanism is on the frame, and its activation does not interfere with the normal oscillation of the seat. After mass measurement, the sear is latched by actuation of the control lever.

6.) The control lever, when actuated in one direction, moves the seat and springs to the offset position, latches the sear, and locks the seat. When actuated in the reverse direction, the control lever unlocks the seat for subsequent manual release of the sear.

7.) The plate-fulcra springs suspend the seat from the frame in the operational mode. When the sear is released, the springs are in an offset position, and their restoring force causes the seat to oscillate. Following measurement, the control lever returns the springs to the offset position.

8.) The collimator shutter is essentially a pair of knife blade edges, one of which is fixed and the other coupled to the seat so as to form a shutter between the light emitting and photosensitive elements of the electro-optical transducer. The shutter action interrupts the emitted light and signals the passage of the seat through its equilibrium position.

2.4.2 Electronics Subsystem

The electronics subsystems for the SMMD of Experiment M074 and for the BMMD of Experiment M172 are identical and are interchangeable in flight.

2.4.2.1 Power Regulator

The power regulator is of the "switching" type which will receive nominal unregulated voltage of 28 $^{+2}_{-4}$ vdc from the spacecraft power supply. The voltage shall be reduced and regulated at a nominal

+5 vdc. The power consumption of the mass measurement device shall average less than TBD watts with possible peak consumption of TBD watts during the actual measurement process. The unit shall withstand continuous operation when subjected to the following conditions and shall give specified performance upon return to the steady state operating voltage of 28^{+2}_{-4} vdc.

(1) Under voltage - Voltage shall not go below the lower limits of the steady state voltage of 28^{+2}_{-4} volts by more than 3.0 volts and shall return to the steady state voltage within one second.

(2) Over Voltage - Voltage shall not exceed the upper limits of the steady state voltage of 28^{+2}_{-4} volts by more than 3.0 volts and shall return to the steady state voltage within one second.

(3) Transients - Voltage transients at the Experiment/OWS interface, from the Experiment or from the OWS, shall not exceed $\pm$ 50 volts peak and 10 microseconds duration.

A block diagram of the power regulator is shown in Figure 2.4.2.1-1. Pulse current is supplied to the passive integrator (storage element) as required to maintain the desired +5 vdc output. Balanced filters are incorporated in the inlet section to reduce conducted EMI on the input lines and to provide protection against transients from the spacecraft source.

2.4.2.2 <u>Temperature Sensor</u>

The temperature sensor shall measure the ambient temperature over the range of 65°F to 80°F with an accuracy of $\pm$ 1°F. The temperature probe is a YSI Thermistor, Part No. 44006, and has the following characteristics.

(1) Resistance: 10,000 ohms at 25°C

(2) Tim Constant: 1 second maximum with thermistor suspended by its leads in a "well stirred" oil bath; 10 seconds maximum with thermistor suspended by its leads in still air. Time Constant is the time

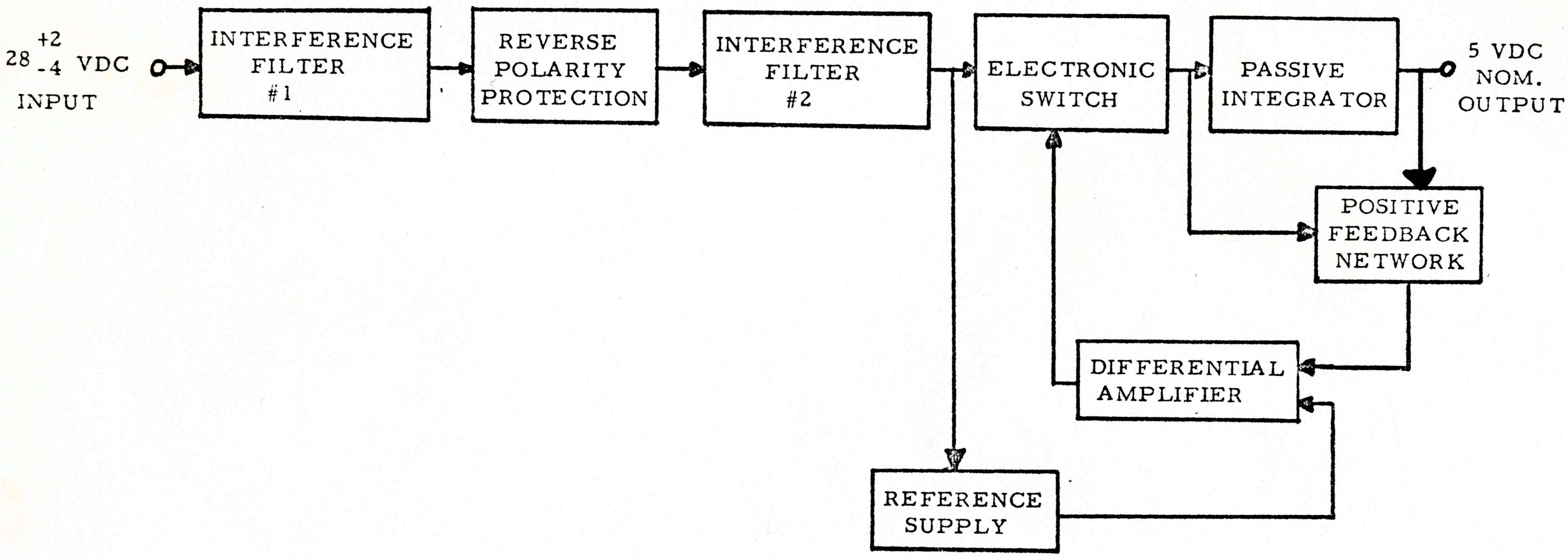


FIGURE 2.4.2.1-1 - BLOCK DIAGRAM OF POWER REGULATOR

required for the thermistor to indicate 63% of a new impressed temperature.

(3) Dissipation Constant: 8 milliwatts per ^{o}C with thermistor suspended by its leads in a "well stirred" oil bath; 1 milliwatt per ^{o}C with thermistor suspended by its leads in still air. Dissipation Constant is the amount of power required to raise the thermistor 1^{o}C above the surrounding temperature.

2.4.2.3 Clock and Digital Logic

The clock and digital logic component consists of a timing generator, seven integrated circuit up/down decade counters, and six BCD to 7-bar converters as shown in the block diagram presented as Figure 2.4.2.3-1. The control logic necessary to perform the functions for mass and temperature measurement is also contained in the clock and digital logic component.

Timing generator is a 1 MHz oscillator having the electrical characteristics shown in Table 2.4.2.3-1.

The signal from the electro-optical transducer component indicates the seat period for mass measurement. The photosensitive transistor of this component sends a signal pulse to the control component. When mass measurement is made, the control resets to zero and permits the intervalometer decade counters to count forward for the period indicated by the electro-optical transducer. The first two oscillation cycles are ignored, and the control allows the timing generator pulses to pass to the intervalometer counters for the next three full seat periods after which the timing generator pulses are blocked.

The intervalometer counters activate the six BCD to 7-bar converters to send electrically stored timing signals to the digital display component.

For temperature measurement, the control resets to zero, presets at a selected number and, in response to the signal received from the temperature sensing thermistor, allows pulses from the timing generator to pass to the intervalometer decade counters for the indicated period of time. As the thermistor has a negative temperature coefficient, the decade counters "count down" on temperature measurement. The counters, in turn, activate the BCD to 7-bar converters to send signals for direct reading in degrees Fahrenheit on the digital display component.

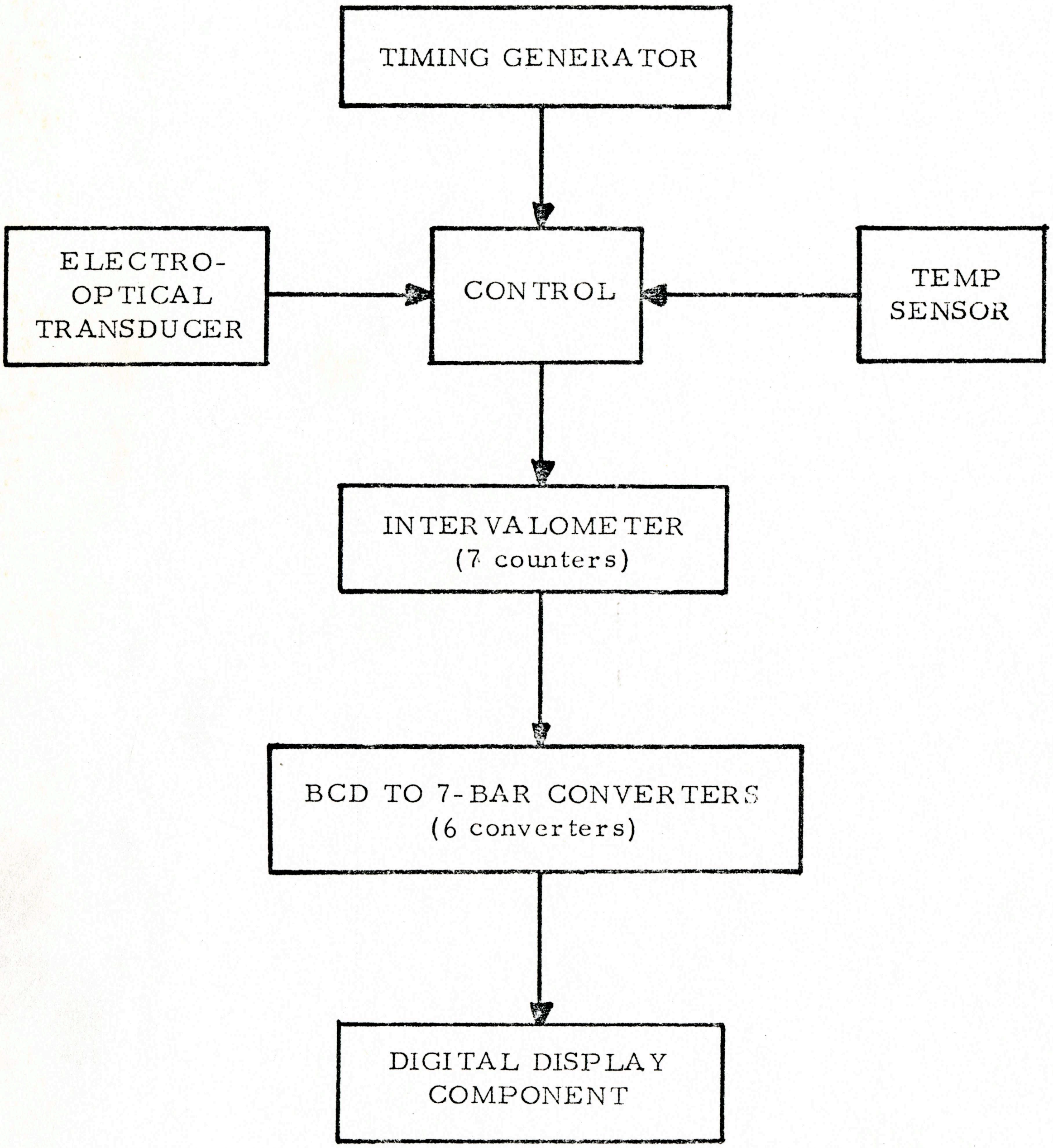


FIGURE 2.4.2.3-1 - CLOCK AND DIGITAL LOGIC

TABLE 2.4.2.3-1 - ELECTRICAL CHARACTERISTICS OF TIMING GENERATOR

Frequency Stability - Short Term vs Time at +25°C	$\pm 1 \times 10^{-8}$/24 hours $\pm 5 \times 10^{-9}$/second
Power Consumption	180 milliwatts
Frequency at +25°C Stability and Accuracy at +25°C	1.000005 MHz $\pm 1 \times 10^{-6}$
Voltage level - Square Wave Logic "O" Logic "1"	 + 0.5 V max + 3.0 V min
Rise and Fall time	compatible to SN5400J Series
Input Voltage	+5 VDC $\pm$ 1%
Input Current	36 mA
Sinking Current (Logic "O")	5 mA
Source Current (Logic "1")	1 mA

2.4.2.4 Digital Display

The digital display component consists of a bank of six individual Monsanto MAN-1 light emitting diode 7-bar numerical displays which read out the 7-bar converter output. Operating on the 5 vdc power output from the power regulator, the digital display presents seat period in 10 microsecond increments up to 6 digits. Temperature measurement is presented directly in degrees Fahrenheit.

2.4.2.5 Electro-Optical Transducer

The electro-optical transducer component senses the mechanical equilibrium position of the seat. The component consists of an infrared diode which emits in the 900 nm wavelength range and an opposing photosensitive transistor. As the seat passes its mechanical equilibrium position, the collimator shutter of the mechanical subsystem interrupts the emitted infrared beam and causes the transistor to send a signal pulse to the control component.

2.5 Interface Control

2.5.1 Mechanical Interfaces

The mechanical interface control document for the M172 Experiment is document No. 13M12101.

2.5.2 Electrical Interfaces

The electrical interface control document for the M172 Experiment is document No. 40M35644.

2.5.3 Flight Crew Interfaces

The flight crew interfaces for the M172 Experiment are identified in Section 6.0 of MSC-KW-D-69-12.

2.5.4 Ground Support Equipment Interfaces

An adjustable platform provided with the BMMD and capable of being leveled, per document GSEDS-2, is required for pre-installation checkout of the BMMD.

SOUTHWEST RESEARCH INSTITUTE

8500 Culebra Road, San Antonio, Texas 78228

Department of Applied Electromagnetics

DOCUMENT NO. CS-2

CONFIGURATION SPECIFICATION

SECTIONS I AND IV

FOR THE

M172 BODY MASS MEASUREMENT DEVICE

FLIGHT HARDWARE

PRELIMINARY - NASA APPROVAL PENDING

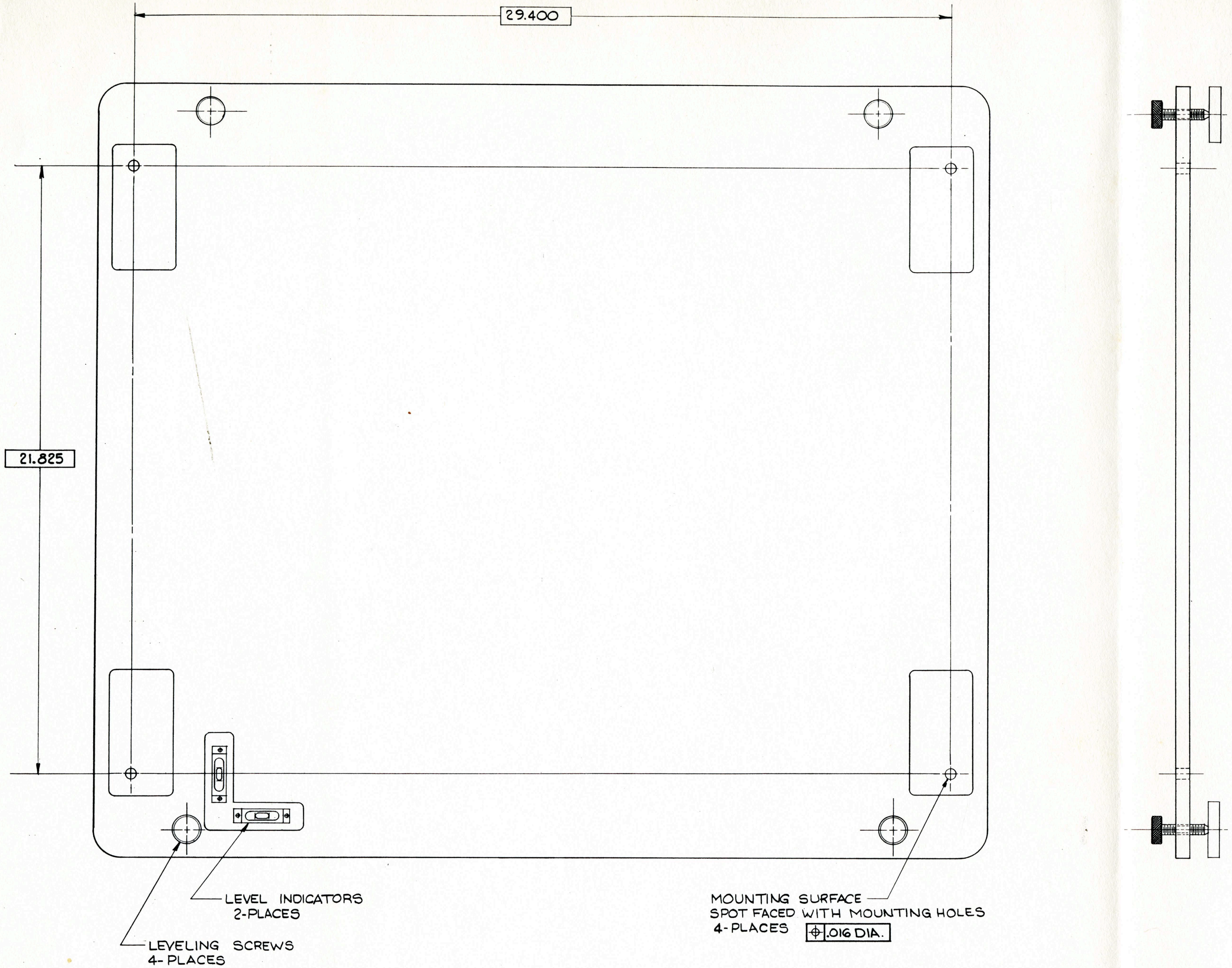
1.0 DESCRIPTION OF BODY MASS MEASUREMENT DEVICE

The body mass measurement device is comprised of a mechanical subsystem and an electronics subsystem. This device is completely self contained with the exception of requiring a nominal 28 volt dc power source and a stable mounting surface.

To operate the device, the subject to be measured lowers himself into the measurement seat and fastens the shoulder straps which comprise the restraint system. The device's electronics are energized and the readout digits are cleared by actuating the reset switch. A control lever releases a lock which prevents the measurement seat from oscillating when not in use, then releases a sear and the measurement seat begins to oscillate.

An optical "zero crossover" unit sends a signal to the device's logic circuit each time the measurement seat crosses the equivalent midpoint in its oscillating cycle. After two cycles have been completed, the total elapsed time for the next three cycles in tens of microseconds appears on the device's readout. The device is shut down by actuating the control lever, which moves the measurement seat to the offset position, latches the sear, and finally sets the locking control to the lock position. The period reading is recorded, and the electronics de-energized. The readings obtained are converted to mass values by reference to a calibration curve, conversion chart, or equation.

Sketch numbers SK-283707, Leveling fixture - BMMD, Preliminary and SK-283706, Body Mass Measurement Device, Preliminary Layout, illustrate the mechanical features of the body mass measurement device.



REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FIND NO.	QTY. REQ.	SIZE	CODE IDENT NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

SIZE	NEXT ASSY	USED ON

APPLICATION

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MATERIAL

FINISH

.5

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE CHEMICALLY APPLIED OR PLATED FINISHES

TOLERANCES

BASIC DIMENSION	DECIMALS 2 PLACE	DECIMALS 3 PLACE	FRACTIONS
UNDER 6	± .0[illegible]	± .005	± 1/64
6-24 INCL	± .03	± .010	± 1/32
OVER 24	± .06	± .[illegible]15	± 1/16
ANGLES ± 1/2°			

COML TOL APPLY TO STOCK SIZES

QTY. REQD.

CONTRACT

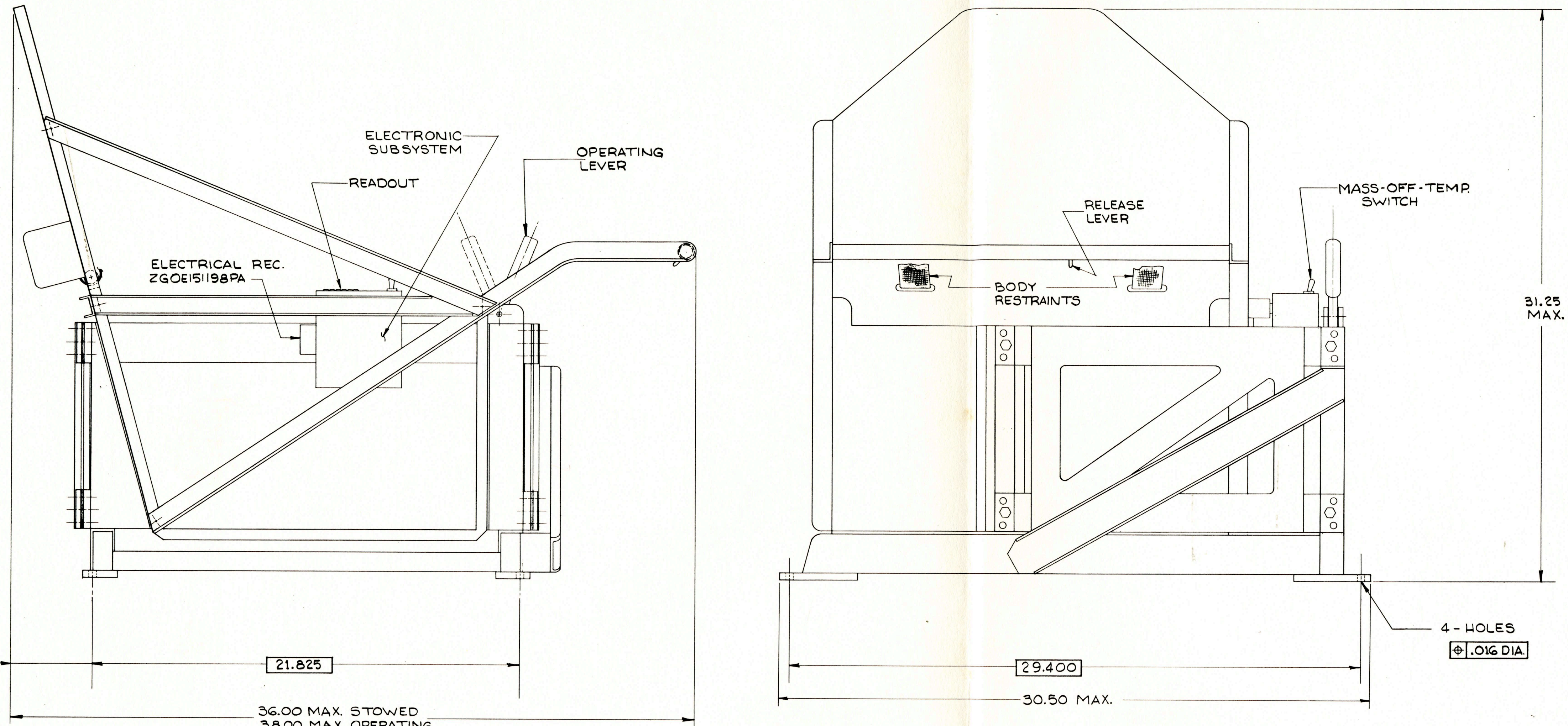
APPROVALS SIGNATURE & DATE		
DRAWN	R.E. Rimmer	7-9-70
CHECKED	R. J. Soltig[illegible]	7-14-70
MECH		
ELECT		
STDS		

SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO, TEXAS

LEVELING FIXTURE-BMMD
PRELIMINARY

SIZE	CODE IDENT NO.	DRAWING NO.
D	26401	SK-283707

SCALE NONE | SHEET



NOTE: MAX. WEIGHT-75 LBS.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FIND NO.	QTY. REQ.	SIZE	CODE IDENT NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

NEXT ASSY | USED ON

APPLICATION

MATERIAL

FINISH

.375

CONTRACT

APPROVALS	SIGNATURE & DATE	
DRAWN	R.E. Rimmer	7-2-70
CHECKED	R.J. Sollog Jr.	7-14-70
MECH		
ELECT		
STDS		

SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO, TEXAS

BODY MASS MEASUREMENT DEVICE PRELIMINARY LAYOUT

SIZE D | CODE IDENT NO. 26401 | DRAWING NO. SK-283706

SCALE NONE | SHEET

2.0 DESCRIPTION OF ELECTRONICS SUBSYSTEM

For purpose of discussion, the electronics subsystem may be broken down into four separate units. These units are the photo detector, the temperature sensor, the intervalometer and the power regulator.

Construction will be such that the four units will be encapsulated into a single module. The SMMD and BMMD electronics subsystem will be identical.

a. Photo Detector

The photo detector unit will sense the equilibrium position of the measurement tray or seat. The first two complete periods of oscillation will be ignored in order to allow any transcients produced by the release mechanism to dissipate. The beginning of the third period will signal a start count to the intervalometer circuit and the beginning of the fifth period will signal a stop count to the intervalometer. The light emitter will consist of a solid state light emitting source in the $9000^{o}A$ wavelength range, while the sensor will consist of a solid state sensing device. The unit will operate from the 5 volts power regulator.

b. Temperature Sensor

The temperature will be sensed by a thermistor probe. This probe will determine the "on time" of a stable integrated monostable multivibrator, which in turn will control the intervalometer circuit. An accuracy of $1F^{o}$ from $65^{o}F$ to $80^{o}F$ will be displayed to the nearest degree by two of the six intervalometer readouts. As common circuits are used by the period sensor and the temperatures sensor, only one parameter may be measured at a time. The temperature will be displayed continuously when the function switch is in the "Temp" position and may be up-dated by depressing the "Temp Sense" push button type switch. The temperature sensor unit will operate with power furnished from the 5 volt regulator.

c. Intervalometer

The intervalometer unit will consist of a 1 MHz oscillator, seven integrated circuit up/down decade counters, six BCD to 7-Bar converters, and six light emitting diode numerical displays. The counter will "count-up" and display the period of 3 measurement tray oscillations when measuring mass. As the thermistor has a negative temperature coefficient, the counter will "count down" when measuring temperature. The control logic necessary to perform the functions for mass or temperature measurements is also contained in the intervalometer unit. The intervalometer will operate with power furnished from the 5 volt regulator.

d. Power Regulator

Voltage regulation of space craft power will be accomplished by a "switching type" regulator. This allows maximum efficiency in voltage regulation. Pulse type current is supplied to a storage element as required to maintain the desired +5 volts dc. An efficiency of approximately 75% is expected. This +5 volts will supply all of the power necessary to operate the entire electronics.

Figures 2.0-1, 2.0-2 and 2.0-3 are block diagrams of the electronics subsystem.

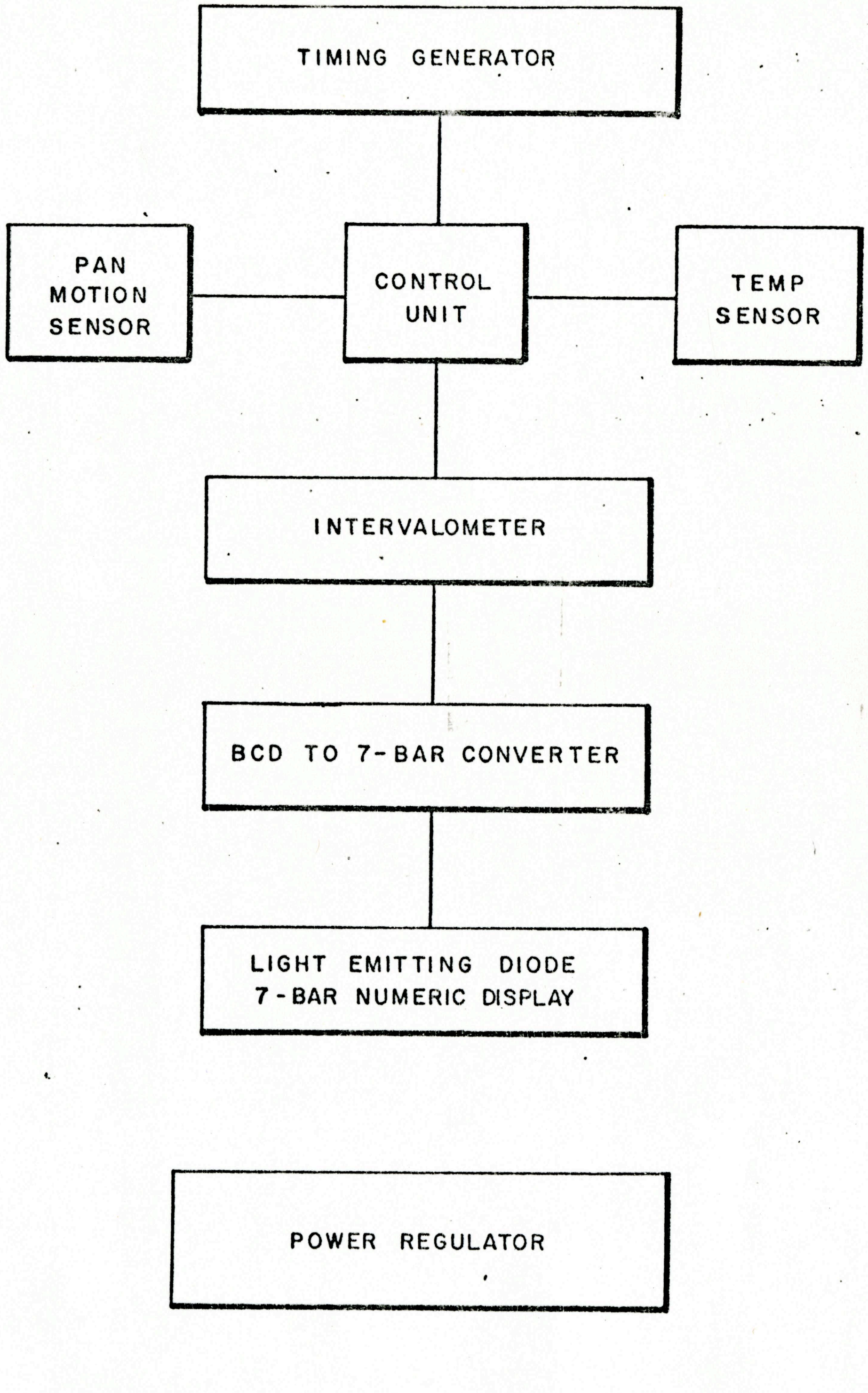


FIGURE 2.0-1 - ELECTRONICS SUBSYSTEM BLOCK DIAGRAM

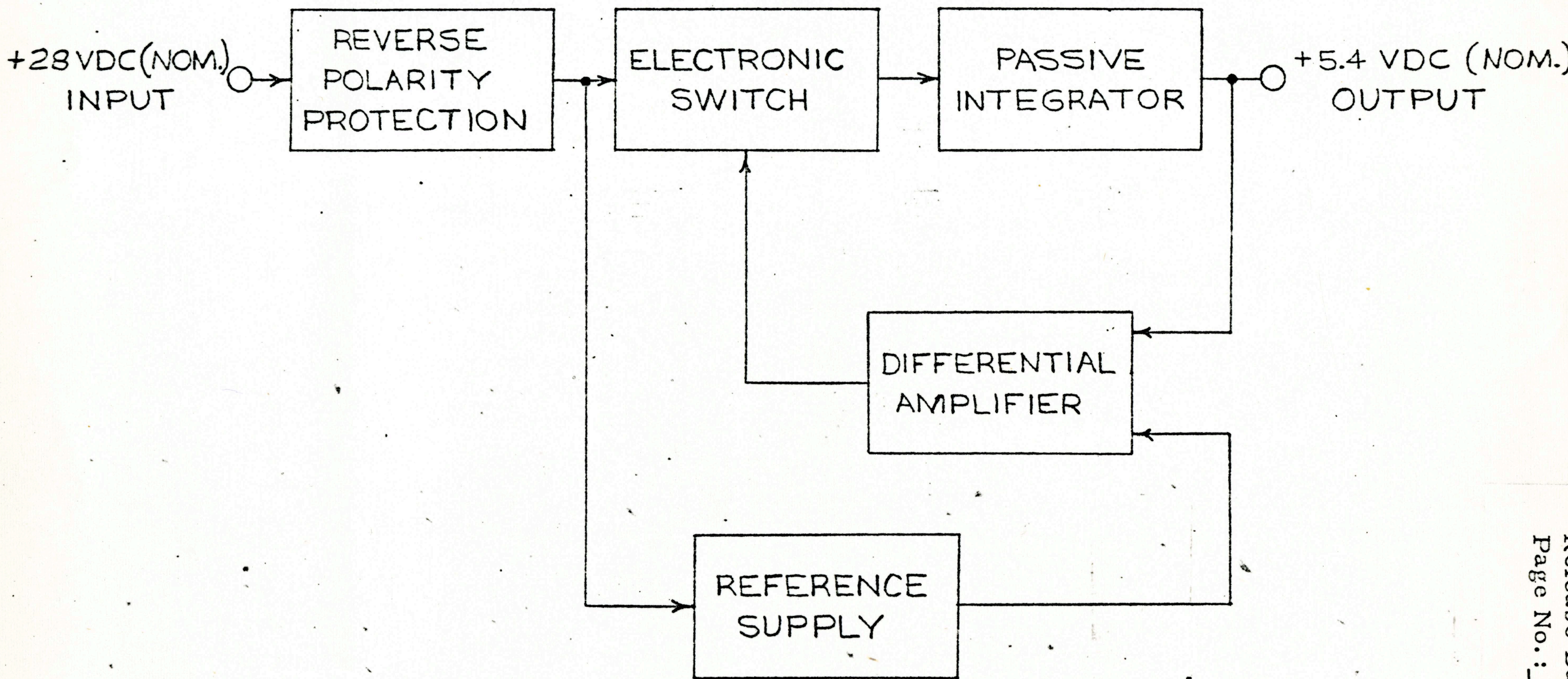


FIGURE 2.0-2 - REGULATED POWER SUPPLY, BLOCK DIAGRAM

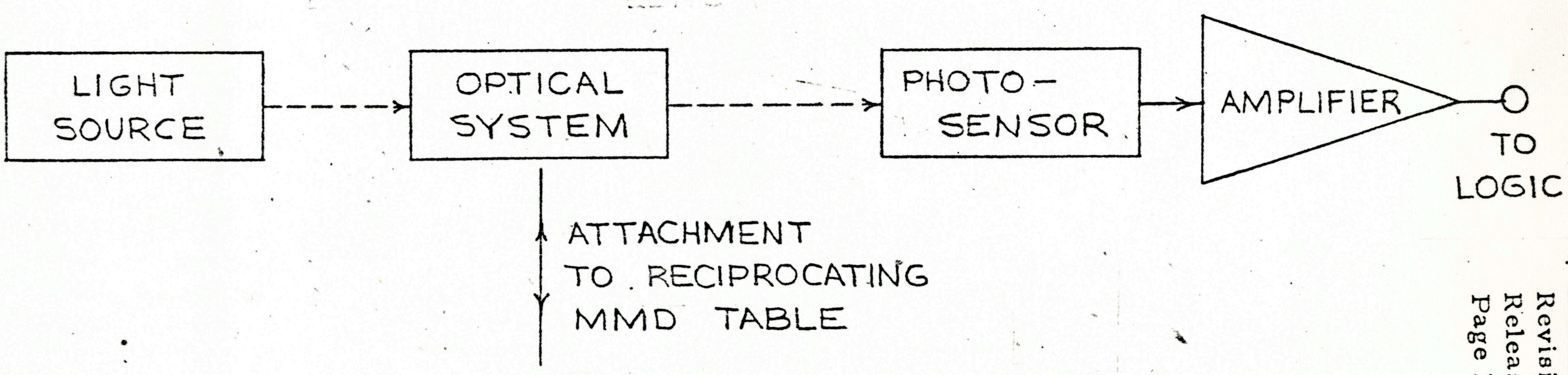


FIGURE 2.0-3 - ZERO-CROSSING DETECTOR BLOCK DIAGRAM