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Dynamic Stability Instrumentation System (DSIS) Volume I: Hardware Description

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Abstract

The paper is a hardware description manual for the Dynamic Stability Instrumentation System (DSIS) that is used in specific NASA Langley wind tunnels. The instrumentation system performs either a synchronous demodulation or a Fast Fourier Transform on dynamic balance strain gage signals, and ultimately computes aerodynamic coefficients. The DSIS consists of a double rack of instruments, a remote motor-generator set, two special stings each with motor driven shafts, and specially designed balances. The major components in the instrumentation rack include a personal computer, digital signal processor microcomputers, computer-controlled signal conditioners, function generators, digital multimeters, and an optional Fast Fourier Transform (FFT) Analyzer.

Introduction

This document, the first volume of a three-volume set, describes each of the Dynamic Stability Instrumentation System rack components.

The Dynamic Stability Instrumentation System determines aerodynamic stability coefficients using a forced model oscillation technique[1]. These coefficients are functions of the forces and moments on the oscillating wind tunnel model. The DSIS consists of a double rack of instruments, a remote motor-generator set, two special stings each with motor driven shafts, and specially designed mechanisms which convert the rotary shaft motion into either a pitch, yaw, or roll motion about the balance oscillation center. The major components in the instrumentation rack include a personal computer (PC), digital signal processor (DSP) microcomputers, computer-controlled signal conditioners, function generators, digital multimeters, and an optional FFT Analyzer. These new racks replace original electro-mechanical resolver-based analog instrumentation[2]. The original motor-generator set used to drive the sting drive motor is used in the new system. The second volume is a software manual that describes the PC software at a functional level and includes information on how to modify the C language code. The third volume describes how to operate the system to obtain the desired aerodynamic damping coefficients.

This paper provides a description of the individual components in the DSIS racks. The function of each component is discussed along with its relationship to the rest of the system. Where relevant, electrical schematics have been included for equipment made in-house. Specifications for the programmable signal conditioners and some of the boards within the PC-386 are listed in appendix A. Also included is appendix B, the cable drawings for pertinent cables in the DSIS.

Component Descriptions

Refer to the block diagram of figure 1 labeled "Cable Layout and Block Diagram" and note that each block represents a chassis or other instrument in the DSIS rack. Signals of interest originate from sensors on the left and are connected to the DSIS by cables labelled with "C" and a number. For example, the G-meter Signal is connected to the DSIS rack via cable C62. A recessed panel on the left side of the DSIS rack (front view), called the Junction Panel, is the location of all of the connectors indicated by the diagram with the "J" and number designation. Signals are processed as they move to the right, or through the DSIS, until they reach the PC-386. A description of each of the blocks in the diagram is now given.

PC-386

This industrial-grade, rack-mounted computer is where most of the data acquisition, conditioning, and reduction take place. It is indicated by a dashed block in figure 1. The PC also controls three (of five) separate signal conditioners and a digital multimeter via IEEE-488, an X-Y plotter via RS-232, and a Laserjet Printer via a parallel port. Several boards reside within the PC and are listed in table 1, which lists each board according to its expansion slot number (numbering from left to right, rear view). The computer uses a passive backplane architecture with the actual 80386-based computer residing on a board, plugged into backplane slot number 11. Additional information on the personal computer is given in the Specifications section. The following discussion describes PC-386 components and their cable connections.

DSP-32C

Located within the PC-386 personal computer are two boards that perform the majority of the signal processing. There are two identical DSP boards that are the heart of the entire DSIS, each labelled DSP #1 and DSP #2 on the drawing in figure 1. These DSP boards plug into PC backplane slots numbered 8 and 9. The boards utilize the WE-DSP32C digital signal processor and have specifications listed in appendix A. After digitizing the analog balance signals to 16-bit resolution, the boards implement the signal processing algorithms[1].

Referring to figure 1, cable C8 connects to the top mini-XLR DSP#1-1 on DSP board #1 and carries the Displacement analog signal. Cable C10 carries the Torque analog signal and is connected to the bottom mini-XLR DSP#1-2. Cable C11 connects to the top mini-XLR DSP#2-1on DSP board #2 and carries the Secondary analog signal. Cable C9 carries the same Displacement analog signal as Cable C8 and is connected to the bottom mini-XLR DSP#2-1. All of these cables are connected at the opposite end to the AC CAL Switch Panel.

DAS-20 Board

The DAS-20 is a multifunction I/O expansion board located in PC-386 slot number 14. Specifications for this board are listed in appendix A. An analog angle-of-attack (AoA) signal, originating from the Q-flex accelerometer, is carried by cable C30 from the Main Interface chassis to channel four of the DAS-20 analog input connector. This signal is digitized by the DAS-20 to 12-bit resolution and is used by the computer to calculate and display the model AoA. In addition, cable C30 carries the displacement, torque, and secondary signals to the DAS-20 board on analog input channels one, two, and three, respectively. These signals are currently not being used by the computer, but can be accessed if needed. Up to 12 other analog signals can be acquired and digitized by the DAS-20 via the breakout board within the Main Interface chassis.

Digital signals are also carried by cable C30. Digital input lines DI0 and DI1 are used to read the state of the motor on/off switch and the wind-on switch, respectively. These two signals, along with the calibrate resistor and signal conditioner on/off signals, which exist within the PC-386 software, are used to determine the data code. Two digital signals corresponding to the state of the calibrate resistor and signal conditioner on/off software switches are sent out on DO0 and DO1 on cable C30, through the Main Interface chassis and on to the digital port of the motor speed controller (where the data code display resides). Three additional channels of digital input or output are available for use via the breakout board.

IEEE Interface Board

This board plugs into PC-386 slot number 13 and enables the PC-386 to interface to any IEEE-488 compatible instruments. The board enables access to all internal settings of each of the three programmable signal conditioners via cable C1. Also, the board is used during calibration to configure and acquire data from the Keithley 2001 digital multi-meter (DMM) via cable C38. The IEEE addresses of the programmable signal conditioners and DMM are 10 and 16, respectively. The HP 3325A and HP3245A Function Generators can be configured via IEEE to automate the calibration process. Refer to DSIS Volume III User Manual for descriptions and procedures of the various calibrations required.

Shaft Encoder Simulator Board (SESB)

This is a custom-made circuit board that resides in PC-386 slot number 5. It is indicated in figure 1 by a box labeled "SESB." The schematic for this board is shown in figure 2. Notice in figure 2, shaft encoder pulses from the RPM Indicator chassis are routed to two sets of digital switches (Quad Switches U6 and U7) on this board through connector J3. Similar signals are generated on board (U1 through U5 and U8) and are also routed to the switches, providing either real or simulated encoder signals. These switches then route the selected signals to connector J2 and on to the Tachometer board. A TTL square wave from the HP 3325A function generator is used to drive the SESB at a frequency of $8192 \times \omega$ to generate these simulated encoder signals, where ω is the oscillation frequency of the pitch-yaw balance. Control of the digital switches is provided by a single manual switch labeled "Cal Enable" which is located on the front panel of the RPM Indicator chassis. Thus, the user must select the type of encoder signal to match the mode of operation: simulated signals for calibration purposes or real signals for normal operation.

Tachometer Board

This circuit board resides in PC-386 slot number 6, counts encoder pulses, and interfaces directly to the DSP boards via a 32-bit data bus. A schematic for this board is shown in figure 3. The quadrature shaft encoder signals (or simulated signals) from the SESB via cable C36 are combined by a logical EXCLUSIVE OR operation resulting in 8192 clock pulses per revolution. An onboard 1 MHz oscillator is counted to determine the oscillation frequncy $8192 \times \omega$. The 1/REV index pulse from the encoder via the SESB is used to reset the counters. Timing pulses are then sent from the board to the RPM Indicator chassis through cable C14 to drive the digital RPM display.

Printer (HP Laserjet II)

An HP Laserjet II printer is connected to the parallel port of the PC-386 via cable C41. The Laserjet is used to produce hard copies of the raw data (voltages) and the data after it has been reduced (coefficients).

X-Y Plotter

An X-Y plotter is connected to the serial port COM1 of the PC-386 via cable C34. This plotter is used to produce plots of the selected coefficients.

VGA Monitor

A color VGA monitor is connected to the PC-386 Graphics Card via cable C58.

Junction Panel

The Junction Panel is a recessed panel on the left side of the DSIS rack. This panel serves as the junction for signals coming from the tunnel and the DSIS. Connectors are numbered and labeled J1 through J12. Each connector assignment and connector type is listed in table 2. Cables from the instrument rack are hard wired into the back of the connectors. Cables from the tunnel are terminated in mating connectors. Once the DSIS rack is located within the "data room," cables can be connected to the DSIS.

The G-meter signal on cable C62 connects to the Junction Panel at J9 and the output is fed through cable C15 to the signal access panel for viewing on the oscilloscope. Power for the G-meter is provided by the heater controller and is routed to the junction panel through cable C16. A small metal enclosure located within the rack near the junction panel contains the signal conditioning for the G-meter. A schematic of the signal conditioning circuit is shown in figure 4.

The displacement signal from the balance is routed to the junction panel thru cable C63 and is connected at J3. The signal is then fed out the back of the panel on cable C18 to the programmable signal conditioners. The torque and secondary signals are routed similarly to the displacement signal: through cable C64, connector J2, and cable C19 for torque; and through cable C65, connector J1, and cable C20 for the secondary signal.

Power for the balance heaters is carried by cable C66 from connector J5 of the Junction Panel. The temperature sensor leads from the balance are routed to connector J4 thru cable C31. The Heater Controller routes power and temperature sensor leads for the front heater/sensor pair together on cable C21 and for the rear heater/sensor pair on cable C22 to the back of the Junction Panel. At the panel, power and sensor leads are split apart. The power for both heaters is routed to connector J5 and the temperature sensor leads are routed to J4.

Model attitude is measured with a Q-FLEX accelerometer whose signal is carried via cable C67 to Junction Panel connector J7 and out through cable C23 to the Q-FLEX signal conditioning chassis. Sting attitude is set by a motor attached to the sting and is powered by cable C59. This cable is attached to the Junction Panel at J10 which feeds through to the Motor Speed Controller Chassis via cable C25. Limit switches for this motor are wired through cable C60 to J11 at the Junction Panel and feed through to the Motor Speed Controller along cable C26.

The frequency of oscillation of the model is measured by an encoder coupled to the sting motor. Signals from the encoder travel via cable C29 to Junction Panel connector J8 and out through cable C24 to the RPM Indicator Chassis. The sting motor is powered by a motor-generator set which is controlled by signals on cable C68 connected at Junction Panel J6. These signals originate from the Motor Speed Controller Chassis and are routed to the back of Junction Panel connector J6 on cable C27.

A switch mounted to the side of the sting detects wind-off and wind-on conditions. Cable C61 connects this switch closure to the Junction Panel at J12. The signal continues along cable C32 to the Data Code Display Panel.

Function Generator (HP3325A)

This instrument is a function generator that is used to simulate a shaft encoder. It provides a TTL square wave signal to drive the shaft encoder simulator board at a frequency of $8192 \times \omega$, where ω is the oscillation frequency of the pitch-yaw balance. This signal originates from the SYNC OUT connector, travels via cable C37 to J1 of the SESB. The shaft encoder signal (or the simulated signal) frequency is divided by 8192 on the tachometer board within the PC and results in the frequency, ω, at which the balance signals are demodulated. The function generator can be set to 0 Hz (square wave signal) and the RPM Indicator front panel encoder switch set to the position labelled "Cal Enable" in order null the DC offset from the programmable signal conditioners. The same signal on C37 also travels on C47 to the Signal Access Panel for viewing on the oscilloscope. Also, cable C46 is connected at the REFERENCE OUT connector and carries the frequency reference to the HP3245A, FREQUENCY REFERENCE connector, to keep the two function generators synchronized.

Function Generator (HP3245A)

This function generator is used for internal calibration of the rack equipment. It is not used during aerodynamic testing. Through front panel input, the instrument generates low frequency sine waves of specified frequency and phase to be used as calibration signals. These signals can be switched into the programmable signal conditioners in place of the displacement on cable C43, secondary on cable C45, and torque signals on cable C44. They are synchronized to the output of the HP3325A (shaft encoder simulator). In addition, a simulated shaft encoder once per revolution (1/REV) signal arrives at connector TB1 via cable C39 from connector J4 of the RPM Indicator Chassis. During AC Calibration, a sinewave signal generated at CHANNEL B OUT by this function generator is carried to the AC CAL Switch Panel along cable C51 to connector HPB.

Programmable Signal Conditioners

The programmable signal conditioners are separate instrumentation amplifiers and filters mounted within a rack mounted chassis. This chassis also includes a microcontroller that communicates with each signal conditioner and with the host computer over the IEEE-488 bus on cable C1. Each signal conditioner is configured with the specifications listed in appendix A. The rack can hold up to eight separate signal conditioners, but only three are used in the DSIS.

The displacement balance signal via Cable C18 (or the calibration signal via Cable C43) arrives at J0 at the rear of the signal conditioner chassis. The torque balance signal via Cable C19 (or the calibration signal via Cable C44) arrives at J1. Also, the secondary balance signal via Cable C20 (or the calibration signal via Cable C45) arrives at J2.

The conditioned displacement signal emerges from connector J10, splits and travels on cable C2 to IB1 of the Main Interface Chassis and cable C52 to the AC Cal Switch Panel, connector DISP1-IN. The conditioned torque signal emerges from connector J11, splits and travels on cable C3 to connector IB2 of the Main Interface Chassis and cable C54 to the AC Cal Switch Panel, connector TORQ-IN. The conditioned secondary signal emerges from connector J12, splits and travels on cable C4 to connector IB3 of the Main Interface Chassis and cable C55 to the AC Cal Switch Panel, connector SEC-IN.

Each signal conditioner is equipped with a bridge completion card (BCC) that is front panel accessible. Located on each BCC are the calibration shunt resistor pairs and several jumpers to configure the BCC. Each BCC is configured with a set of shunt resistor pairs as shown in table 3. The second column in this table lists the value of each of the shunt resistors while the third column lists the corresponding signal amplitude (Channel Gain = 1) computed using a bridge resistance of 350 Ohms and a bridge voltage of 5.0 Volts. These values will change if the gain is increased since the shunt resistors are connected across the balance arms prior to the gain stage within the signal conditioners.

Heater Controller

Figure 5 is a schematic of the Heater Controller chassis, which is used to control the temperature of the balance. The balance incorporates two temperature sensors and two heaters. The Heater Controller has two independent channels mounted together in one chassis. Each channel consists of a Kepco power supply and a Shimaden temperature controller. The front panel of each controller is labelled "Front" or "Rear," indicating which balance heater is controlled. An operating temperature (150°F) is set on the front panel of the temperature controller along with upper and lower limits (±4°F about the set point). The controllers are set up to use a three-wire RTD input. This minimizes errors in the temperature reading due to lead wire lengths. The heater and temperature sensor leads for the front channel are routed through cable C21, which is connected to the rear of the Heater Controller chassis. Cable C22 has similar leads for the rear channel. Once these cables reach the junction panel, the heater leads are paired together into connector J5 and the temperature sensor leads are paired together into connector J4.

Q-Flex Signal Conditioner

This two-channel instrument is used to process the angle-of-attack (AoA) accelerometer current signal to a proportional voltage signal by providing a precision load resistor. Figure 6 is a schematic of the signal conditioner. The instrument also provides power for the accelerometer and low-pass filtering for the output. The output voltage signal is sent to the DAS-20 board through the Main Interface Chassis. This output signal can be calibrated to indicate AoA given the proper constants. Only one channel of the instrument is used. The accelerometer output on cable C23 arrives at connector Q-FLEX Input at the rear of the chassis. The conditioned signal is routed through the FIL OUTPUT connector through cable C12 to connector IB4 of the Main Interface Chassis.

G-meter Output Circuit

This circuit is located within a small grey metal enclosure mounted just below the Junction Panel and its schematic is shown in figure 4. Its purpose is to provide signal conditioning for a piezoelectric accelerometer mounted in the sting. A five-volt dc power supply in the heater controller chassis provides the excitation for this circuit via cable C16. The output of this circuit is routed on cable C15 to the Signal Access Panel. The signal can be monitored visually using the fourth channel of the oscilloscope to insure that sting vibrations do not exceed specified limits. (The first three channels are used to monitor the three balance signals.)

RPM Indicator

This chassis provides one of two independent measurements of the shaft encoder angular velocity. Figure 7 is a schematic of this chassis. A four-digit LED display on the front panel indicates this measurement in units of Hertz. Pulses from the encoder enter the chassis via cable C24 through connector J2. These pulses are routed directly to connector J3, and together with a calibration enable signal they are sent via cable C17 to connector J3 of the Shaft Encoder Simulator Board. The calibration enable signal depends on the state of a switch labeled "Calibrate Enable / Encoder" located on the front of the chassis. Also on connector J3 is a 1/REV pulse coming back from the Shaft Encoder Simulator Board. This signal is passed out of the RPM Indicator chassis through connector J4 on cable C39 and on to the HP 3245A function generator where it is used as a synchronizing pulse. Timing pulses are received by connector J1 over cable C14 from connector J3 of the Tachometer board in the PC. These are the pulses that are used to drive the display on the front panel.

Motor Speed Control and Data Code Display

This chassis provides control of the sting mechanism for model attitude adjustment, control of the oscillation frequency, and display of the data code. A schematic of this chassis is shown in figure 8. The model attitude is manually adjusted using an up/down toggle switch located on the front panel of the chassis. Large amplitude current supplied by the AoA Drive 40 VDC power supply along cable C28 enters the chassis through connector MC2 and passes through the up/down switch. This current is then routed toward the AoA motor on cable C25 from connector MC4. The switching of this high current causes electrical noise on the data lines in the rack; however, since data is not taken while model attitude is being changed, this is not a problem. Two limit switches, which are located on the sting, are connected to the chassis via cable C26 through connector MC3. Control of the oscillation frequency of the model is achieved by a potentiometer labelled "Frequency" on the front panel of the chassis. This potentiometer sets a control voltage through a divider circuit. This control voltage is then sent out through rear connector MC1 through cable C27 to the Junction Panel connector J6 and on to the MG set, which drives sting oscillation mechanism.

The data code is used to associate certain parameters with a set of data. Data codes are determined by the states of two hardware and two software switches. The two hardware switches are the motor on/off switch, located on the front panel of the Motor Speed Control chassis and the wind-on switch, located on the sting. The state of the wind-on switch is transmitted to the chassis via cable C32 through connector MC6. The software switches correspond to the state of the programmable signal conditioners and the calibration resistors. The states of the software switches are transmitted to the Data Code Display through the digital output port from the DAS-20 board. Connector MC5 transmits the state of the hardware switches to and receives the state of the software switches from the DAS-20 board. The values and corresponding data types for the data codes are listed in table 4.

AC Cal / Normal Switch Panel

A schematic of this panel is shown in figure 9. This panel provides a manual switch that connects all DSP inputs to one output of the HP3245A function generator (AC CAL switch selection), or to the appropriate programmable signal conditioner (NORMAL switch selection). "AC CAL" means AC calibration mode while "NORMAL" means normal operating mode. The OPEN switch selection disconnects all inputs from all outputs and is not used.

During NORMAL switch operation, the conditioned displacement signal, which is on cable C52, connects to the DISP-1 input and is routed to the DISP-1 output connector where cable C8 carries it to DSP#1-1 in the PC-386. Cable C9 carries it to DSP#2-2, and cable C5 carries the signal to the Signal Access Panel. This same conditioned displacement signal is fed through the Main Interface Chassis and emerges from connector IB10, traveling along cable C53 to connector DISP-2. The conditioned torque signal, which is on cable C54, connects to the TORQ input and is routed to the TORQ output connector where cable C10 carries it to DSP#1-2 in the PC-386 and cable C6 carries it to the Signal Access Panel. The conditioned secondary signal, which is on cable C55, connects to the SEC input and is routed to the SEC output connector where cable C11 carries it to DSP#2-1 in the PC-386; and cable C7 carries it to the Signal Access Panel. One of the three conditioned balance signals from the Keithley Switch Panel is carried via cable C56 to the KEITHLEY input connector. This signal is internally routed to the KEITHLEY output connector where it then travels to the rear input connector of the Keithley 2001 DMM via cable C57.

During AC CAL switch operation, sinewave signals generated by the HP3245A function generator are carried via cable C51 to connector HPB-IN. Internal switches route this signal to the following output connectors: DISP-1, DISP-2, TORQ, SEC, KEITHLEY. In addition, the HPA and HPB output connectors are unterminated open circuits.

Main Interface Chassis

A schematic of this component is illustrated in figure 10. This chassis provides a means of accessing conditioned balance and (model attitude) accelerometer signals. Connectors provide the user with access to monitor these signals using an oscilloscope. The chassis also houses the break-out board for the DAS-20 board for digital and analog I/O. A description of the chassis follows.

The displacement signal from the programmable signal conditioner on cable C2 enters the chassis through rear panel BNC connector IB1. This signal is redirected through the chassis to the rear panel BNC connectors IB10 and IB11. The displacement signal is used by both DSP boards. The coaxial shield is the signal common. In addition, the displacement signal can be accessed for display on an oscilloscope by using rear panel BNC connector IB12.

The torque signal from the programmable signal conditioner on cable C3 enters the chassis on connector IB2. This signal is redirected through the chassis to connector IB6. In addition, the torque signal can be accessed for display on an oscilloscope by using connector IB7.

The secondary signal from the programmable signal conditioner on cable C4 enters the chassis on connector IB3. This signal is redirected through the chassis to connector IB8. In addition, this signal can be accessed for display by using connector IB9.

In order to provide for future capabilities, the displacement, torque, and secondary signals are also connected to a separate analog-to-digital conversion (ADC) board in the PC (the DAS-20 board). This connection is accomplished by screw terminal block TB-1 inside the screw terminal labelled STA-20, as shown in drawing number 6461. A internal 50-conductor flat ribbon connects the screw terminal to the chassis rear panel at connector IB14. Cable C30, a 50-conductor flat ribbon cable, connects to the DAS-20 board inside the PC-386.

The model attitude signal on cable C12 from the Q-Flex instrument is connected to IB4, a male KPT type connector. Notice in figure 10 that the operational amplifier (op-amp) U1 acts as a buffer for the attitude signal. Op-amp U2 amplifies the buffered signal. In addition, op-amp U3 adds a variable DC voltage offset to the attitude signal. Within the Main Interface Chassis, the model attitude signal is routed to channel four of the DAS-20 analog input.

The user can set this offset level by adjusting front panel access potentiometer R6 labelled "AoA Offset".

Test points are provided to monitor the attitude signal at various stages and for hardware checkouts. An oscilloscope channel can be connected to the front panel BNC labelled "TEST POINTS." A switch is provided to monitor the following signals: raw output of the Q-flex instrument on position "1," output of the buffered stage on position "2," output of the fixed gain of 40 stage on position "3," and output of the DC offset stage on position "4." Other test points provide checks on +15 VDC and -15VDC.

A data code is passed through the main interface chassis at rear panel connector IB15 along cable C33. The conductors in this cable pass digital information to and from the computer via the DAS-20 interface board. The motor on/off and wind-on signals are inputs to the computer while the calibrate resistor and amp on/off signals are outputs to the Motor Speed Controller Chassis.

Oscilloscope (Tektronix 5111A)

A four-channel analog oscilloscope is used to visually monitor the three signals from the output of the AC Cal/ Normal Switch Panel. These may be either the displacement, torque, and secondary signals from the balance (after the programmable signal conditioners), or the AC calibration signals from the HP 3245A. The scope displays the same signals that the DSP boards receive, which depend on the AC Cal/Normal switch. A fourth signal, the G-meter output, is also monitored here. Other signals that can be monitored include the TEST POINTS from the Main Interface Chassis, the sinewave and encoder signals from the two function generators, and the calibration synchronization (TTL level) signal from the HP3325A.

Signal Access Panel

The Signal Access Panel is simply a focal point for accessing several different signals. The three balance signals or AC calibration signals (depending on the AC Cal/Normal switch) are routed to this panel to be displayed on the scope. The G-meter signal is routed here before going to the scope. The SYNC OUT pulse from the HP3325A is also routed here for monitoring. The incoming signals are fed through the back of the panel to BNC connectors located on the front.

Digital Multimeter (Fluke 75)

This hand-held DMM is used to measure the displacement signal voltage accessed via the Signal Access Panel BNC labelled "Displacement" using cable C35. This cable is long enough to extend from the DSIS back to the test section, where the user can manually adjust model attitude. A hand crank is inserted into the bottom rear of the sting and rotated until the DMM indicates the "null'" value. Turning the hand crank causes the model to change attitude. This is done to position the model correctly for balance calibration.

FFT Analyzer (Ono Sokki CF 6400)

A four-channel, 16-bit FFT analyzer was incorporated into the DSIS to provide a alternate method of computing the dynamic stability coefficients. Instead of the conditioned balance signals going to the DSP boards for processing, they are routed to the FFT analyzer. The analyzer then computes frequency, magnitude, and phase information for the balance signals. Once these computations have been made, the information is stored to floppy disk by the operator and used in a data reduction program. From here, the dynamic stability coefficients can be calculated [3]. The analyzer is not required for normal DSIS operation and can be removed at any time.

Digital Multimeter and Keithley Switch Panel (Keithley 2001)

The instrument is a digital multimeter used to measure the conditioned balance signals during calibration and to monitor these signals during normal operation. This meter is controlled by the PC-386 via the IEEE-488 cable C38. Each of the balance signals pass through the Main Interface Chassis and are connected to the Keithley Switch Panel. The switch panel enables the user to select one of the three conditioned balance signals for monitoring while in the Normal operating mode.The output of this switch on cable C56 is connected to the KEITHLEY input connector on the AC CAL Switch Panel.

Regulated AC Supply

A regulated AC power supply is located in the bottom right (front view) of the DSIS cabinet. This unit is used to power the components which would be adversely affected by noisy AC line voltage, such as the PC-386, programmable signal conditioners, and the Q-Flex signal conditioner. Table 5 lists each component in the DSIS rack and its power source.

Power Supply (Sorensen 40-25)

This is a 40 volt, 25 amp power supply that is used to drive the attitude motor. The output is fed through cable C28 into the Motor Speed Controller where it is switched by the attitude Up/Down switch. For the attitude motor, the output is limited to 28 volts.

Cable Descriptions

A listing of all the cables used in the DSIS is provided in table 6. The table lists the cable number, type of connectors, type of cable, starting and terminating destination, the signal that the cable carries, and the length of each cable. The cable number can be cross referenced to figure 1, Cable Layout and Block Diagram. Appendix B contains a drawing for each cable.

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Appendix A

Specifications for specific components of the DSIS are listed below.

PC-386

- 16 MHz 80386DX processor
- 640x480x256 .28 resolution VGA color monitor
- 2 DSP-32C boards
- DAS-20 Analog and Digital I/O board
- IEEE-488 board
- 2 in-house developed tachometer related boards
- 8 Meg RAM
- 80 Meg Hard Drive
- 10 slot passive ISA Bus Backplane
- Two 5¼" DSDD Floppy Drives
- 2 serial and 1 parallel port

DSP32C

- 50 MHz WE DSP32C digital signal processor
- Zero wait state 64K SRAM
- 32-bit digital I/O interface bus
- Two analog input channels with 16 bit sigma-delta converters
- 64 tap FIR digital anti-alias filters

DAS-20 Board

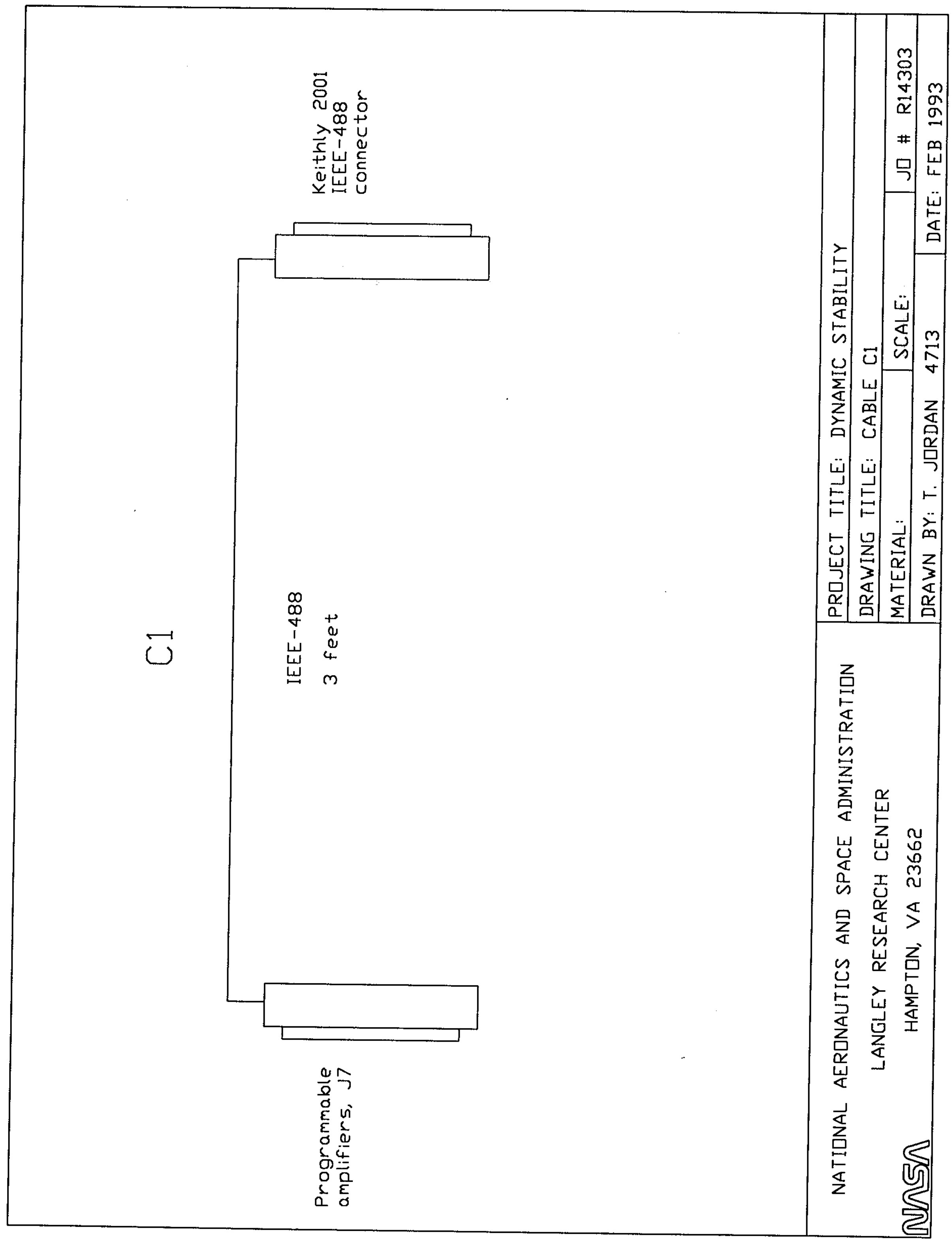
- 16 channel, single-ended, multiplexed, 12-bit A/D converter
- 16 digital I/O lines
- 2 channel 12-bit D/A converter

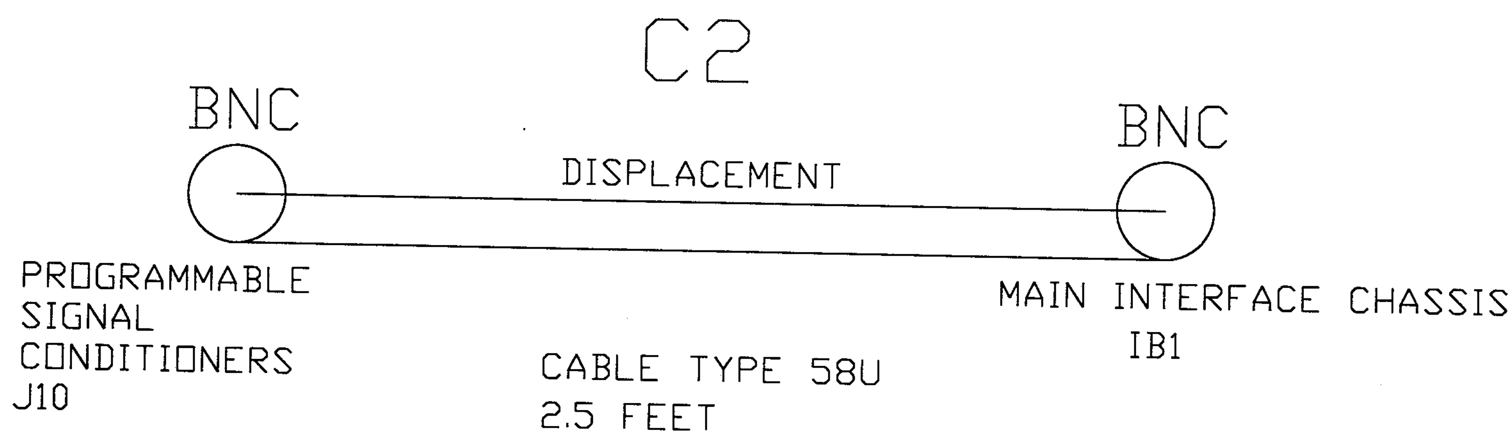
Programmable Signal Conditioners

- 500KHz wideband amplification
- Selectable Gains: 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, & 10000
- Anti-Alias Filter: 300 Hz Lowpass Frequency Cutoff, 6-pole Butterworth
- 50M Ohm Input Impedance

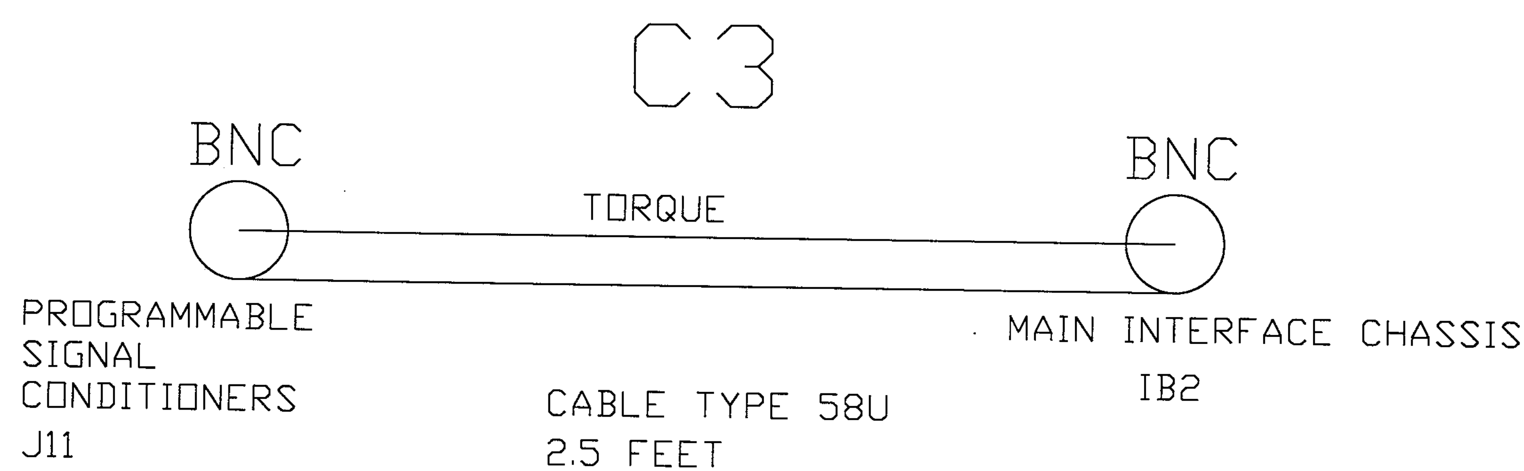
Appendix B

Specific cable drawings are shown below for reference purposes.

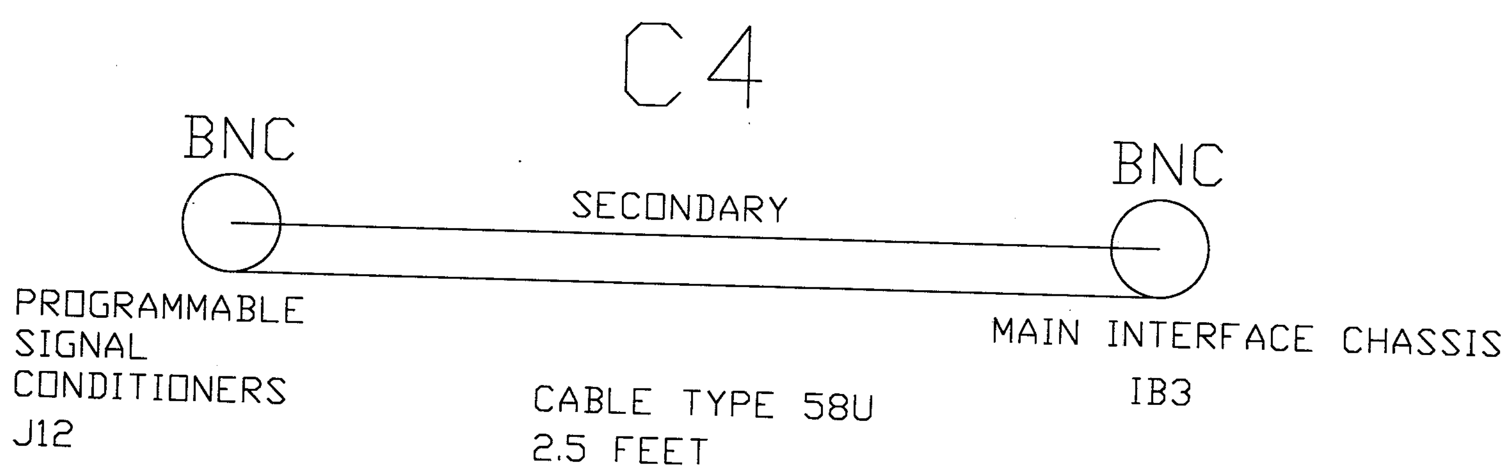




NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C2		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: JAN 1992

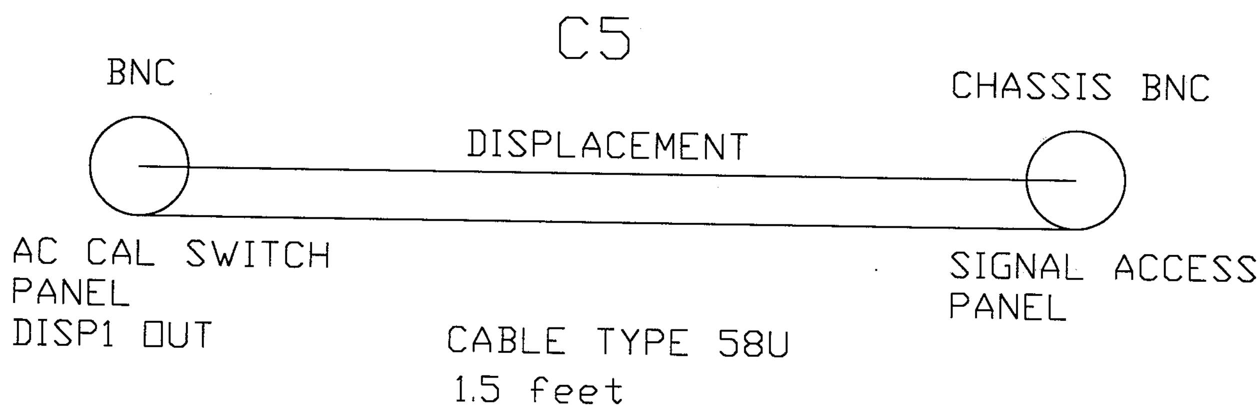


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY	
	DRAWING TITLE: CABLE C3	
	MATERIAL:	SCALE: / JO # R14303
	DRAWN BY: T. JORDAN 4713	DATE: JAN 1992

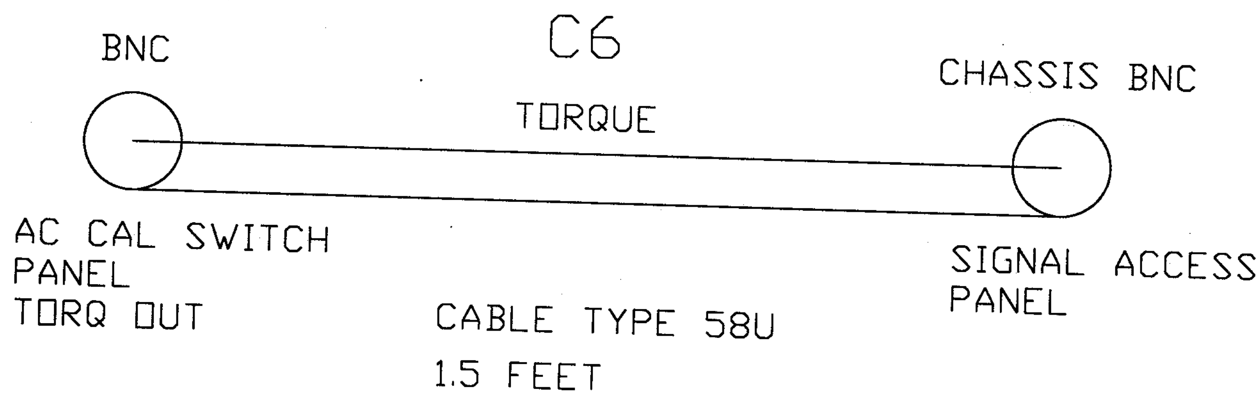


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C4		
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713		DATE: JAN 1992

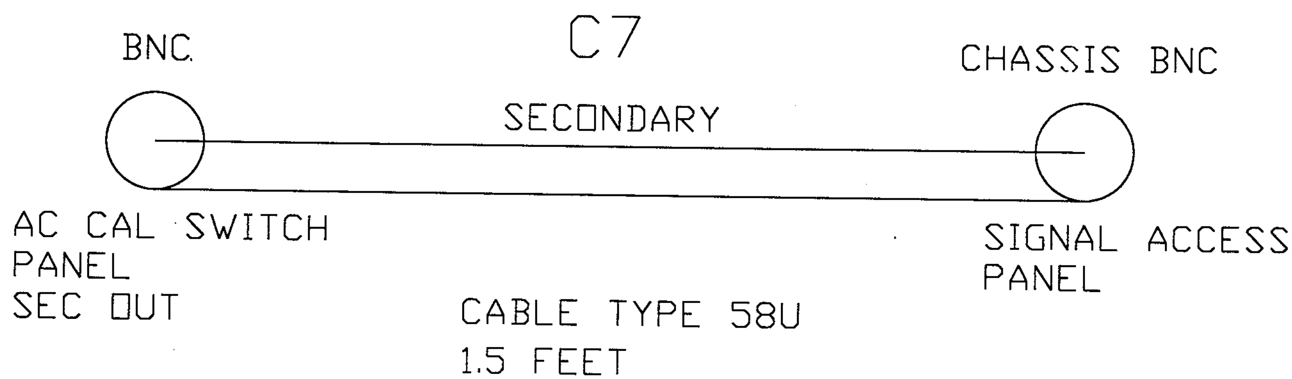


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C5		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: MARCH 1992

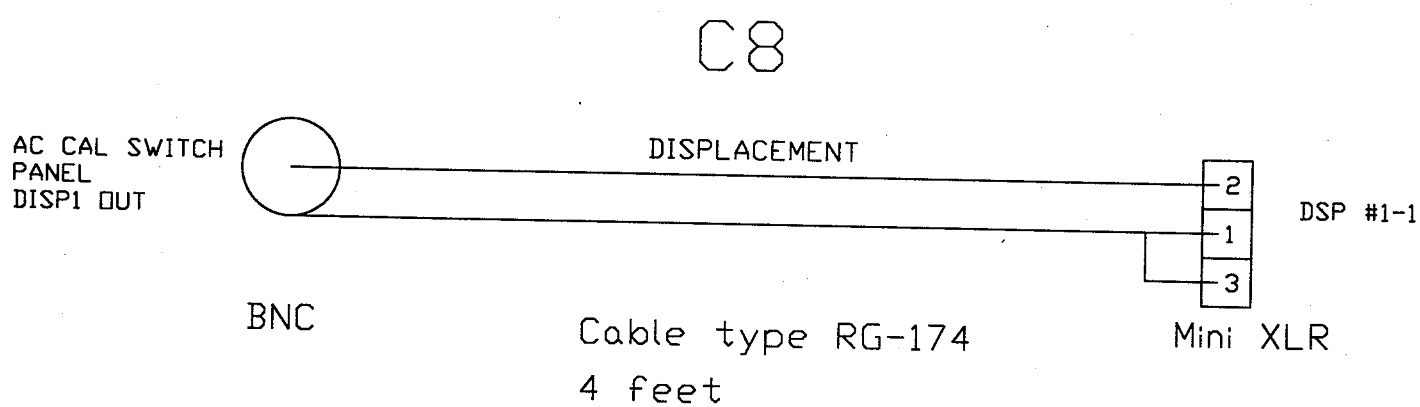


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

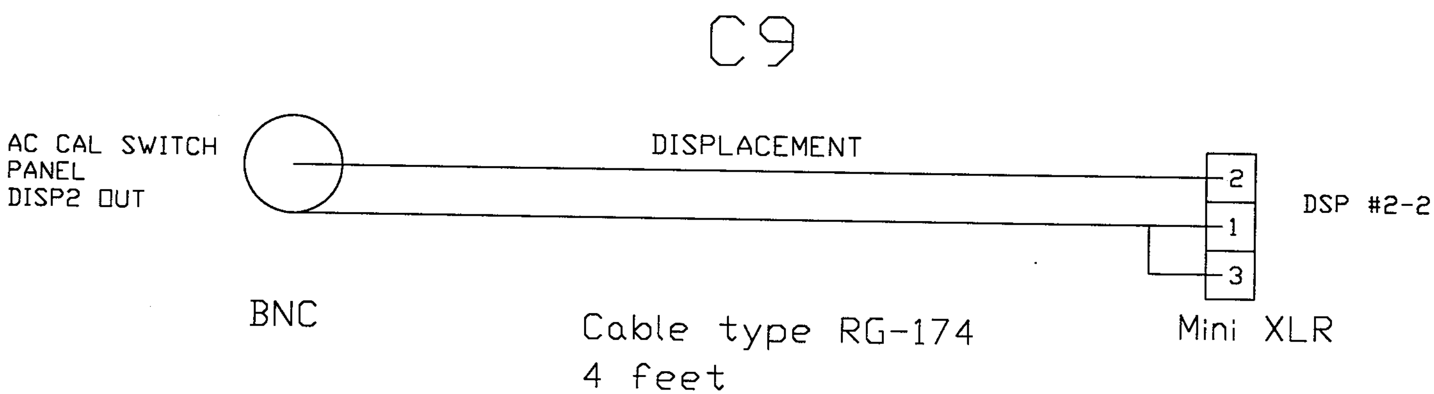
PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C6		
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713		DATE: MARCH 1992



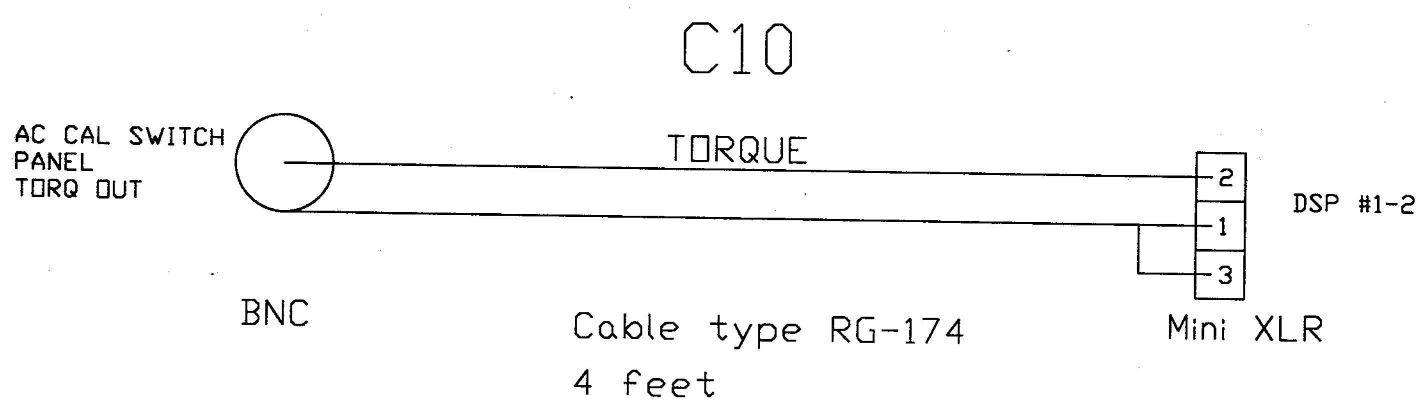
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY	
	DRAWING TITLE: CABLE C7	
	MATERIAL:	SCALE: / JO # R14303
	DRAWN BY: T. JORDAN 4713	DATE: MARCH 1992



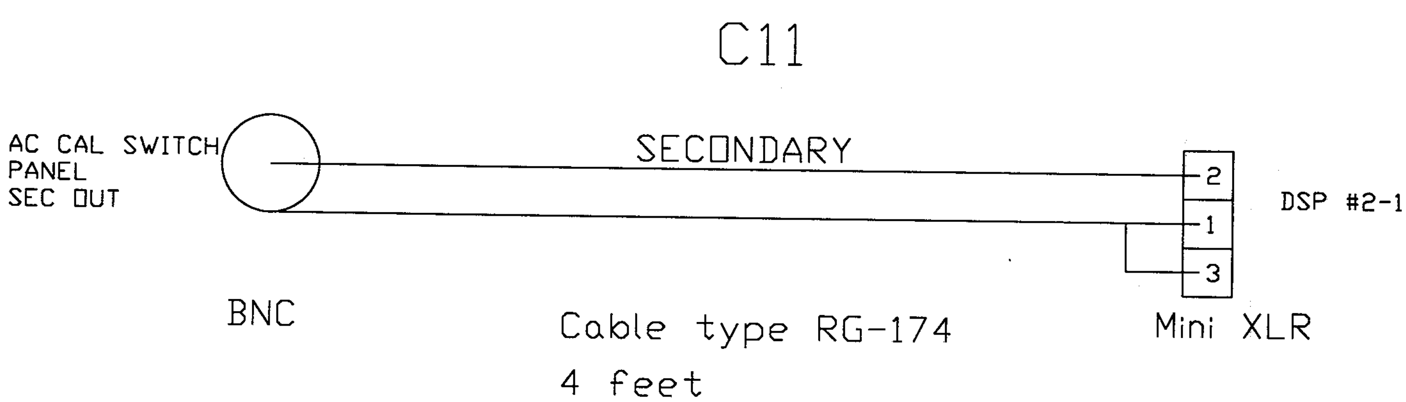
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY	
	DRAWING TITLE: CABLE C8	
	MATERIAL:	SCALE: · JO # R17177
	DRAWN BY: T. JORDAN 4713	DATE: JAN 1992



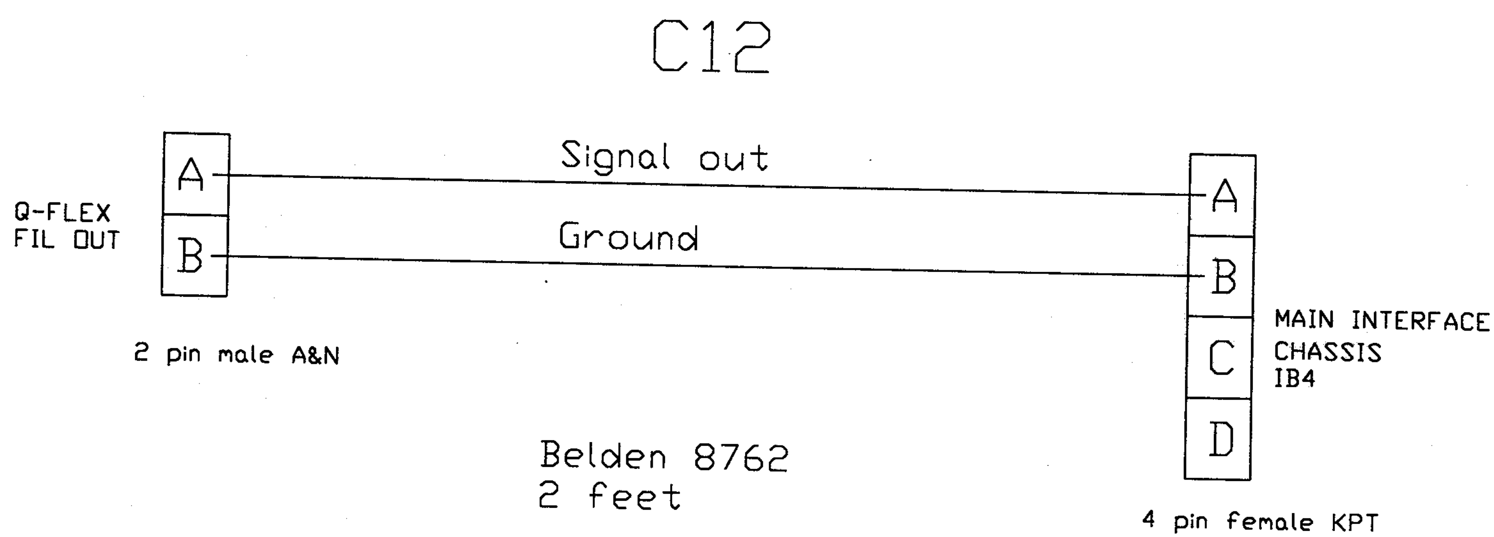
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C9		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: JAN 1992



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C10		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: JAN 1992

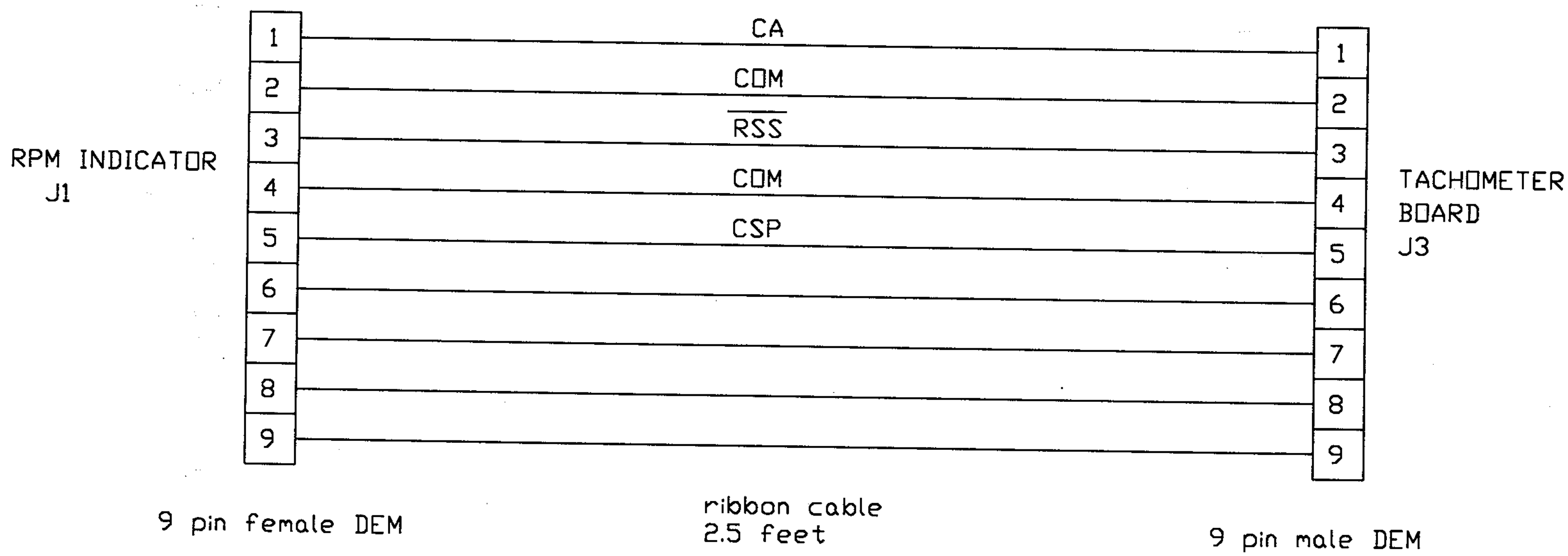


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C11		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: JAN 1992



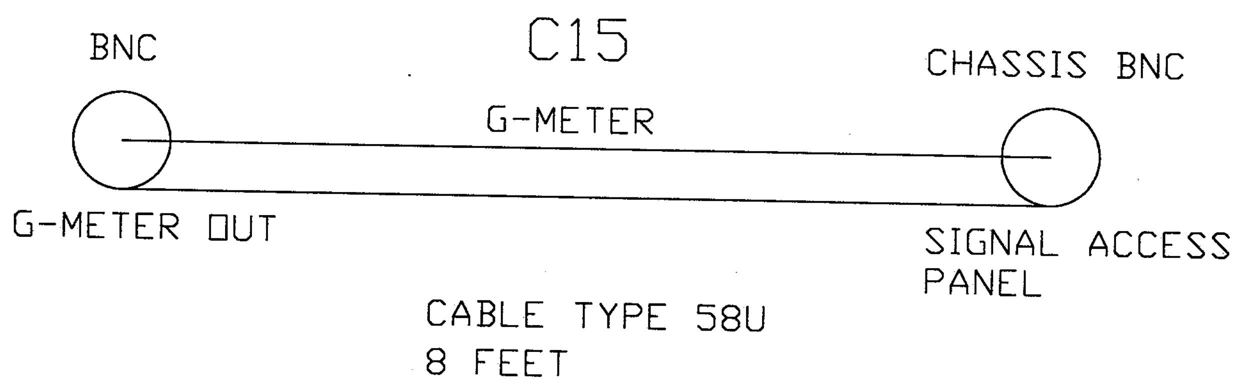
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY
	DRAWING TITLE: CABLE C12
	MATERIAL: SCALE: JO # R14303
	DRAWN BY: T. JORDAN 4713 DATE: JAN 1992

C14

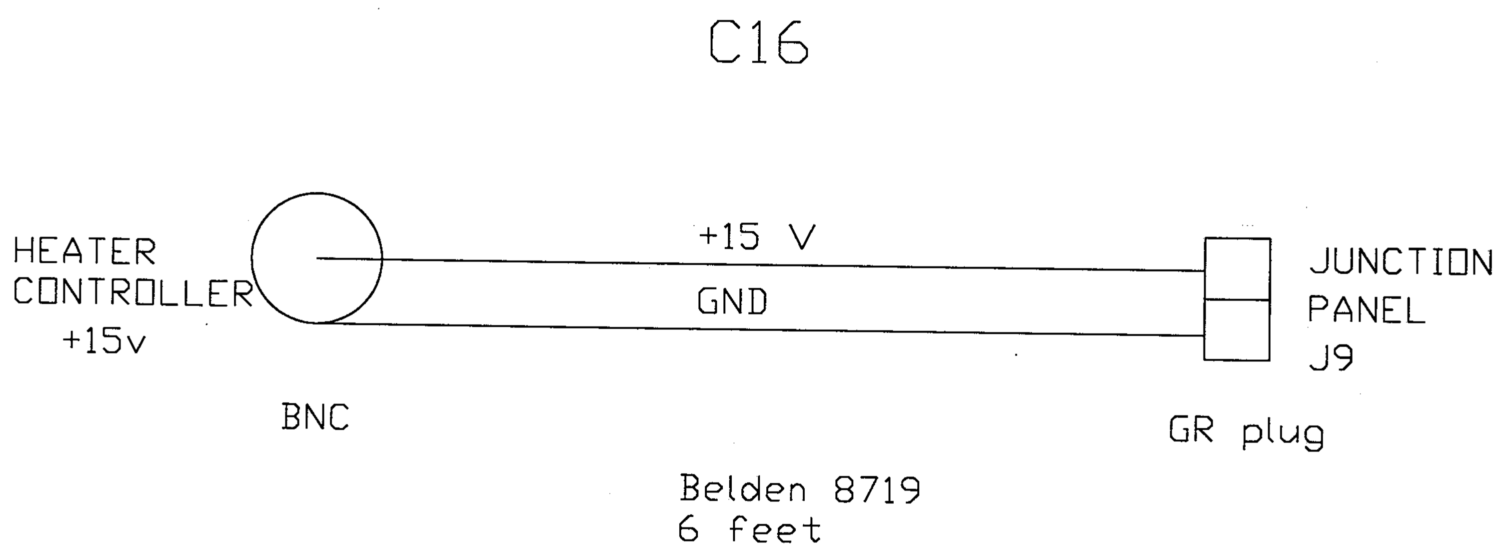


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

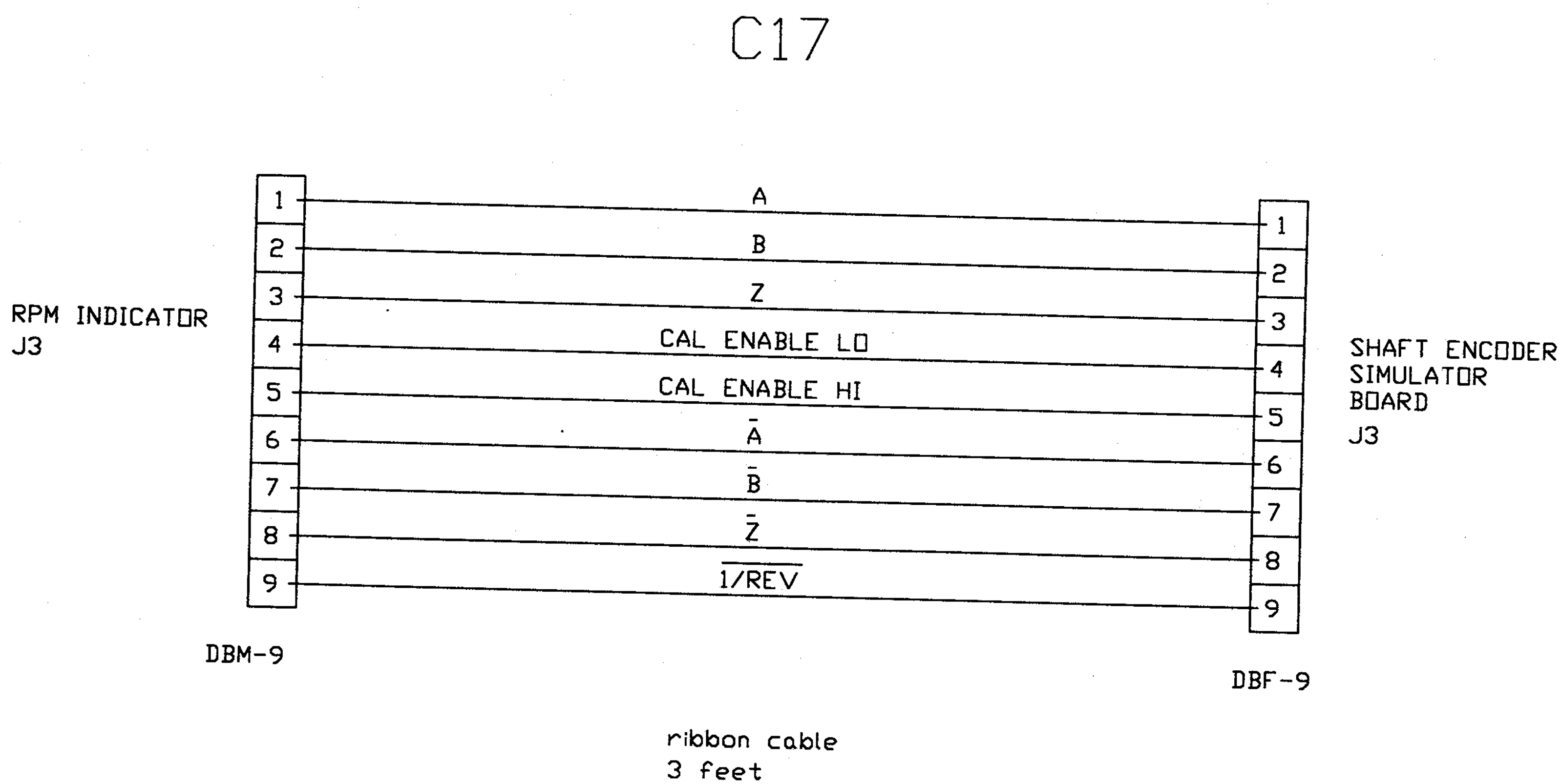
PROJECT TITLE: DYNAMIC STABILITY	
DRAWING TITLE: CABLE C14	
MATERIAL:	SCALE: / JO # R14303
DRAWN BY: T. JORDAN 4713	DATE: MARCH 1993



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C15		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: MARCH 1992



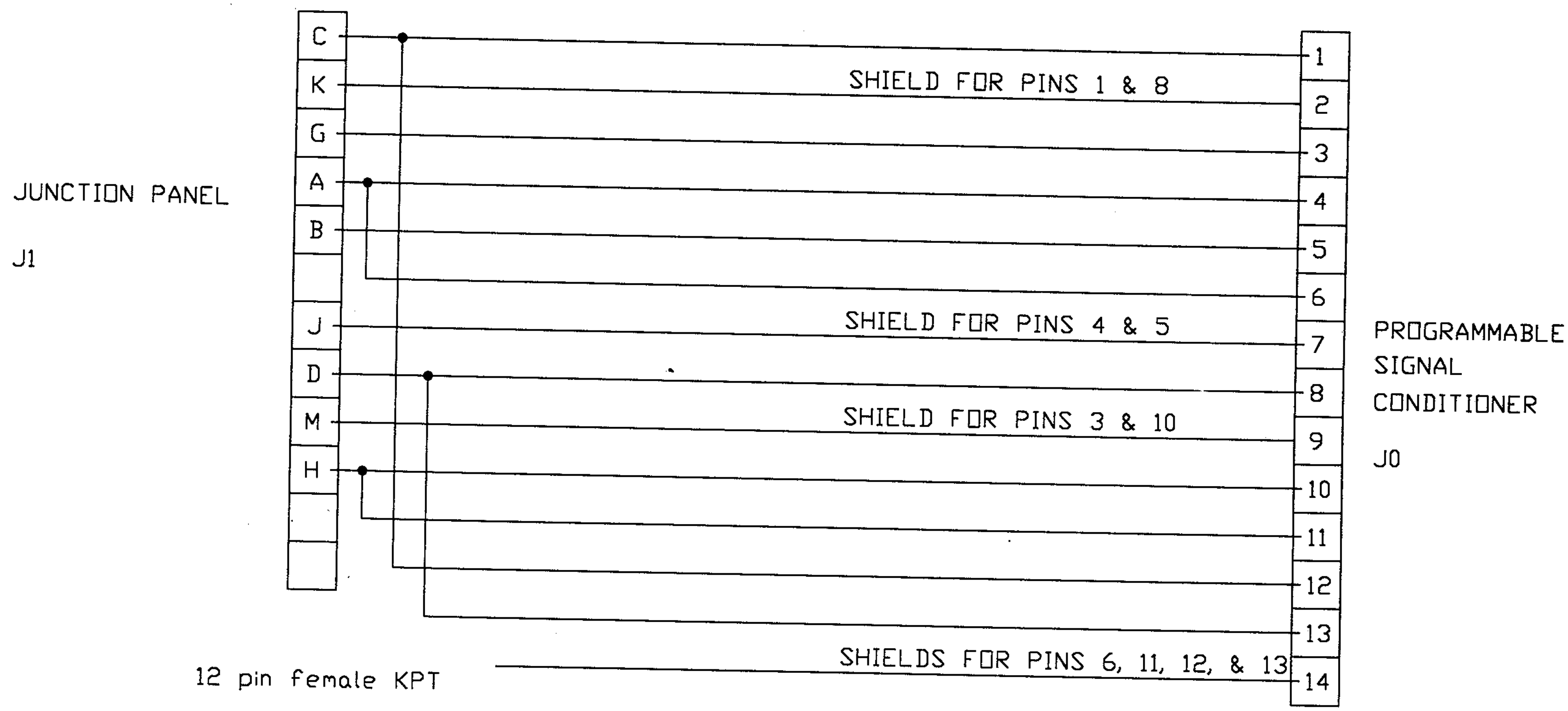
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY
	DRAWING TITLE: CABLE C16
	MATERIAL: | SCALE: | JO # R14303
	DRAWN BY: T. JORDAN 4713 | DATE: MARCH 1992



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C17		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: FEB 1993

C18

Displacement



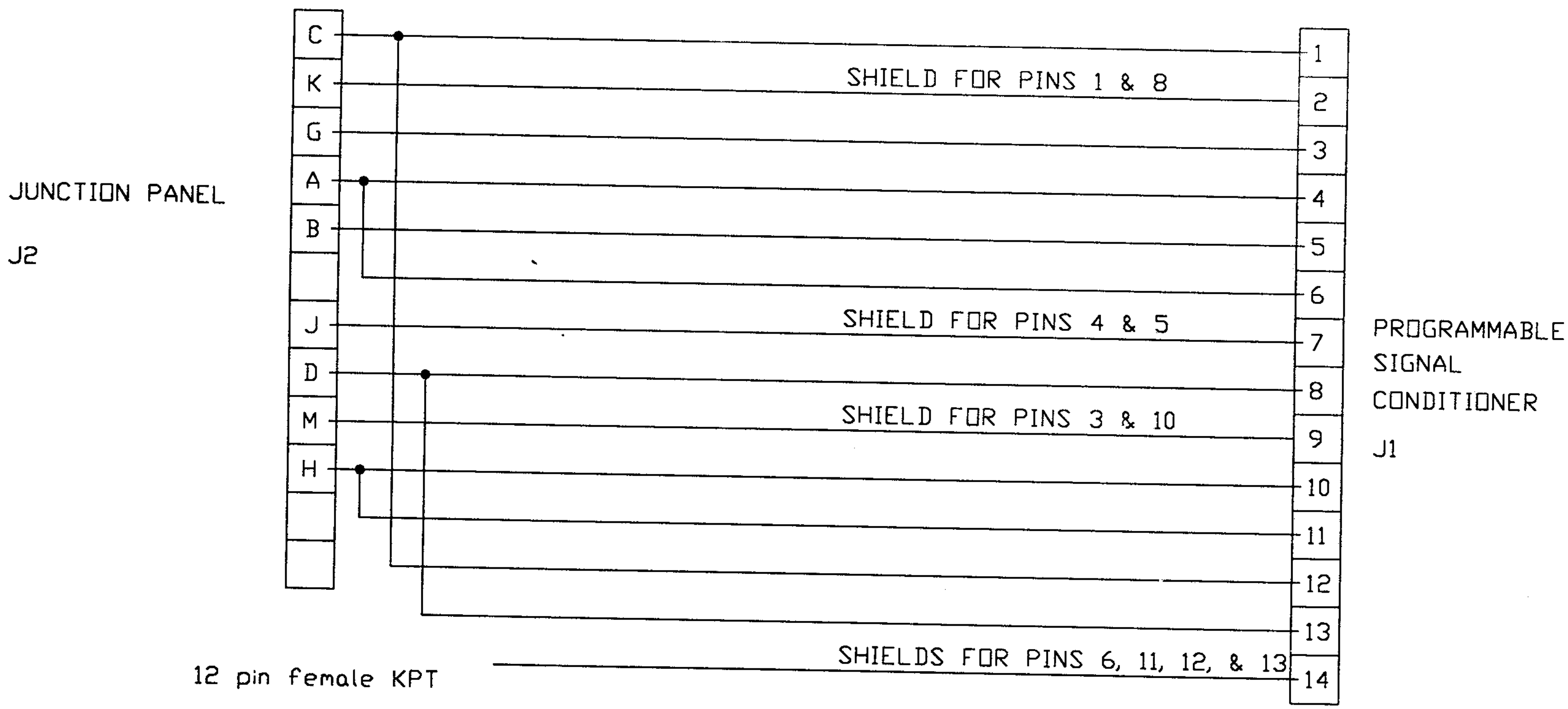
Belden 8761 for pins 1, 8, and 2.
Belden 8725 other pairs
Pins 1&8, 3&10, 4&5, 6&11, 12&13
to be twisted pairs with shield
8 feet

Amphenol series 57
57-30140

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY DRAWING TITLE: CABLE C18 MATERIAL: SCALE: JO # R14303 DRAWN BY: T. JORDAN 4713 DATE: JAN 1992

C19

TORQUE

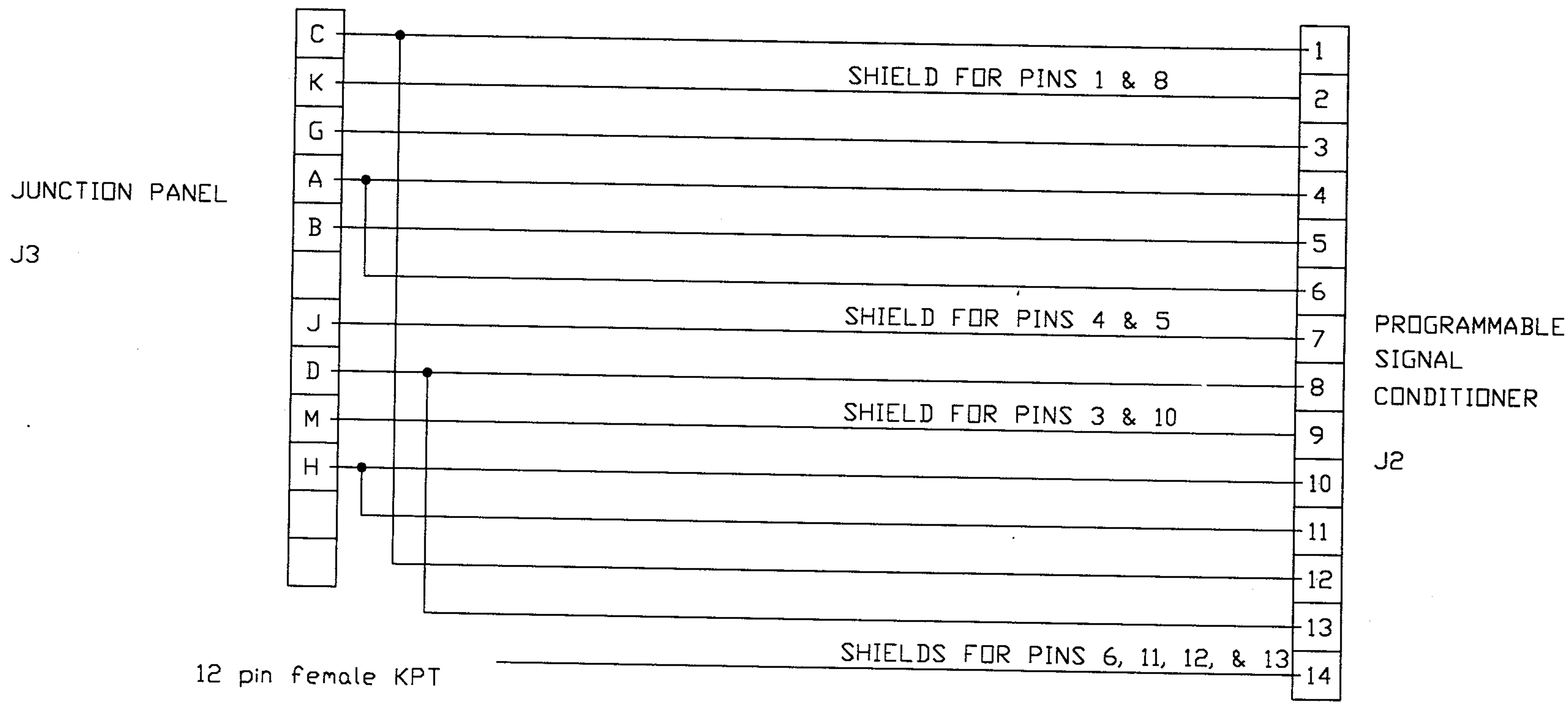


Belden 8761 for pins 1, 8, and 2.
Belden 8725 other pairs
Pins 1&8, 3&10, 4&5, 6&11, 12&13
to be twisted pairs with shield
8 feet

Amphenol series 57
57-30140

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C19		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: JAN 1992

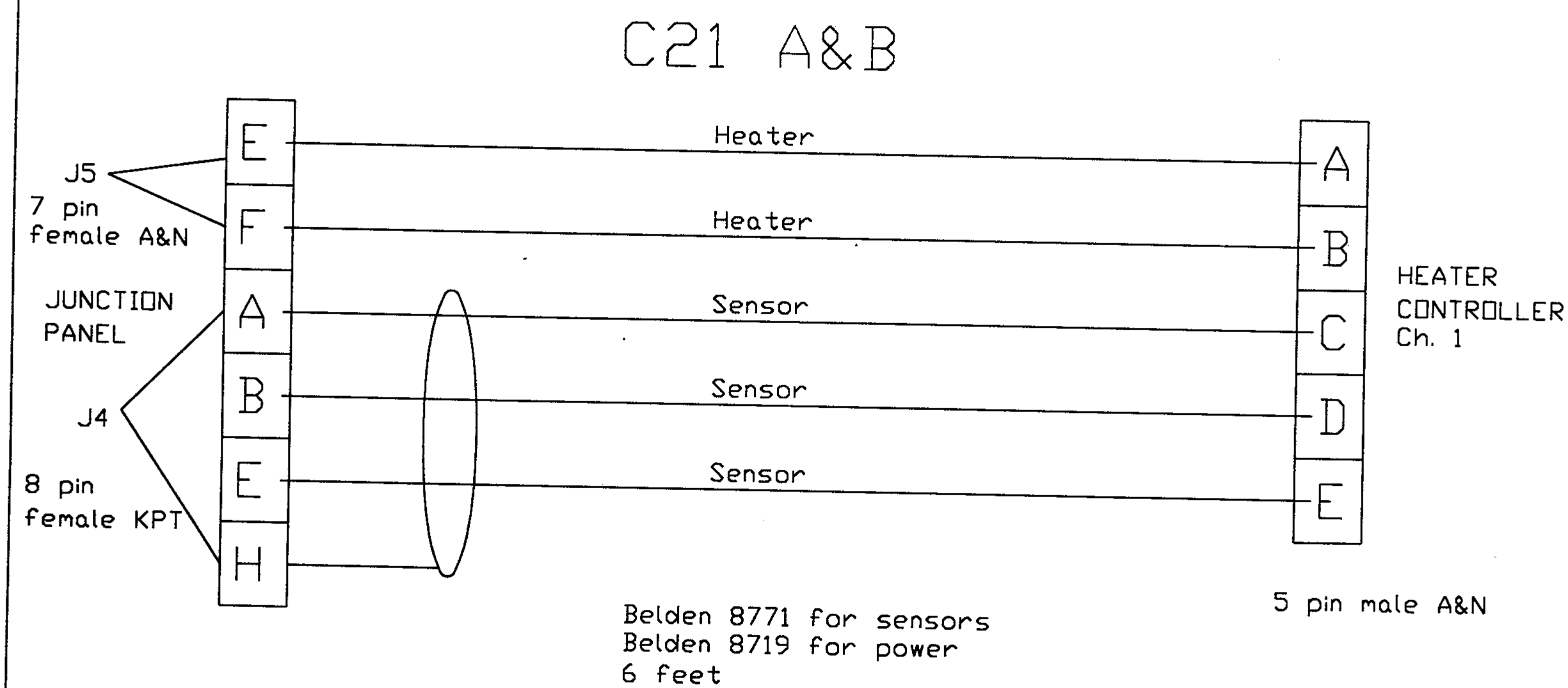
C20
SECONDARY



Amphenol series 57
57-30140

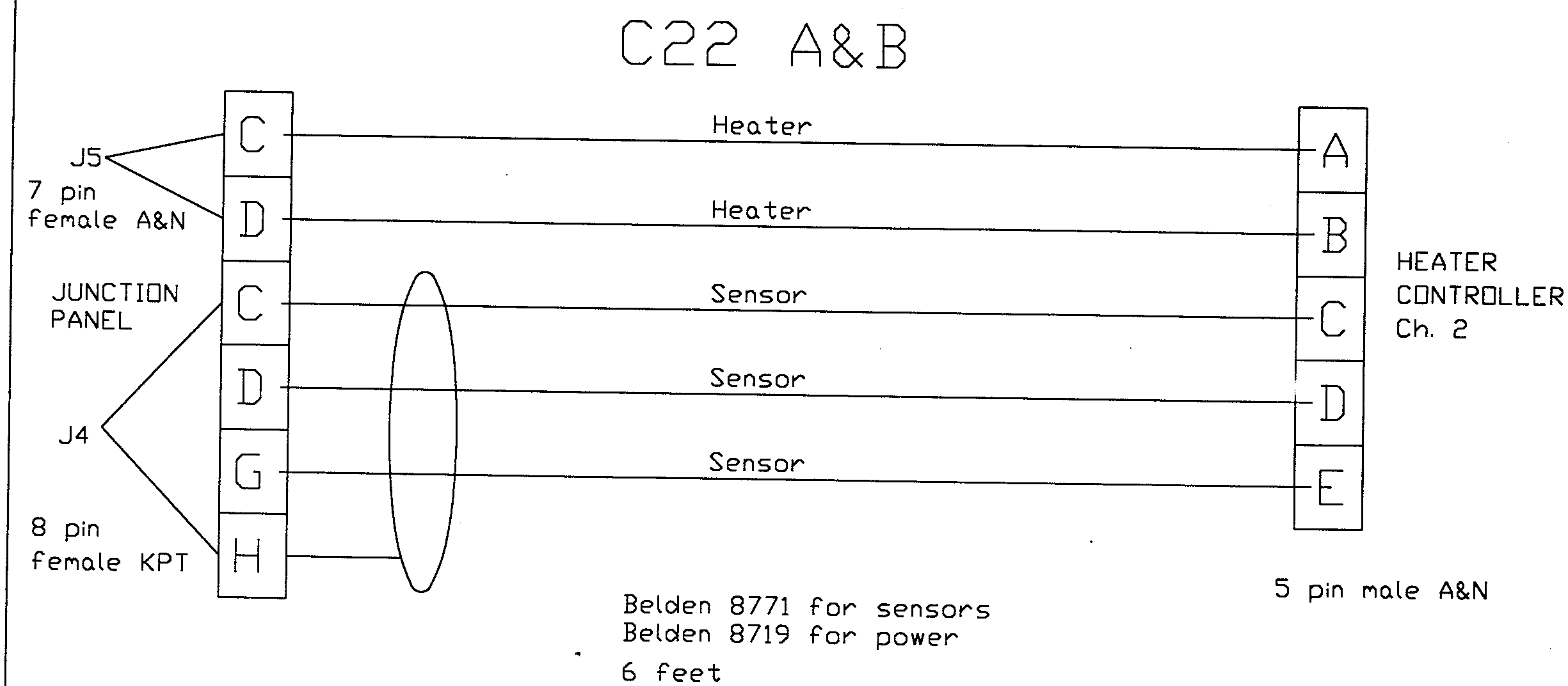
Belden 8761 for pins 1, 8, and 2.
Belden 8725 other pairs
Pins 1&8, 3&10, 4&5, 6&11, 12&13
to be twisted pairs with shield
8 feet

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY	
	DRAWING TITLE: CABLE C20	
	MATERIAL:	SCALE: / JO # R14303
	DRAWN BY: T. JORDAN 4713	DATE: JAN 1992

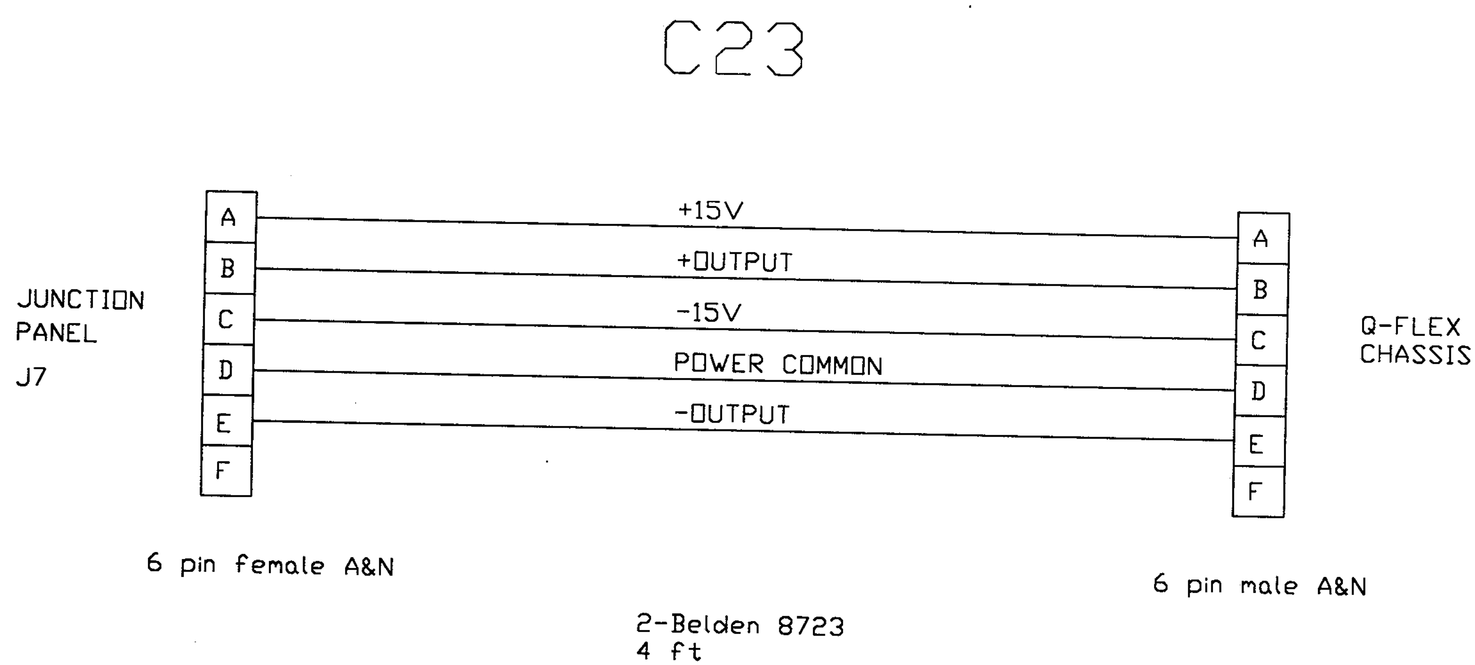


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

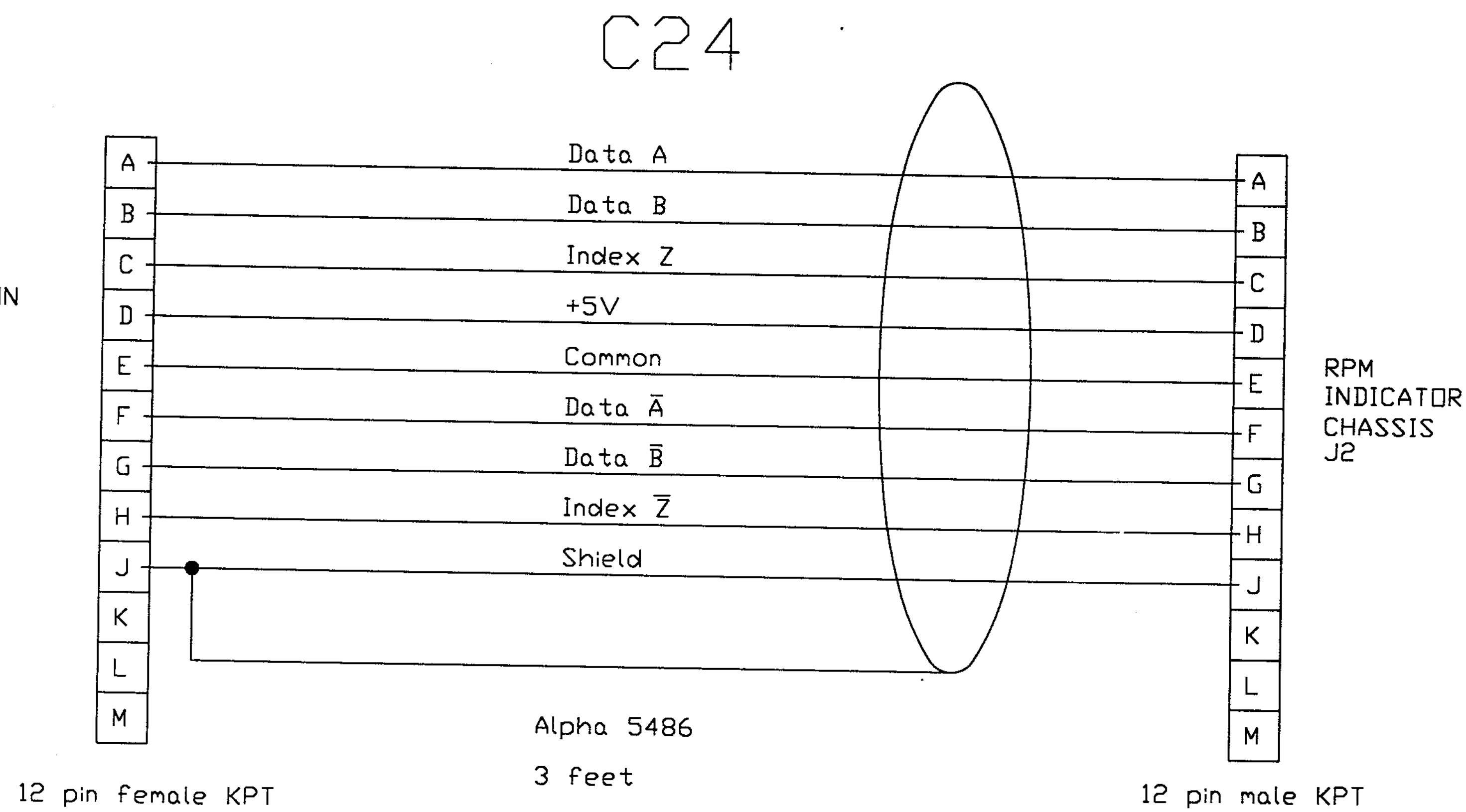
PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C21		
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713		DATE: JAN 1992



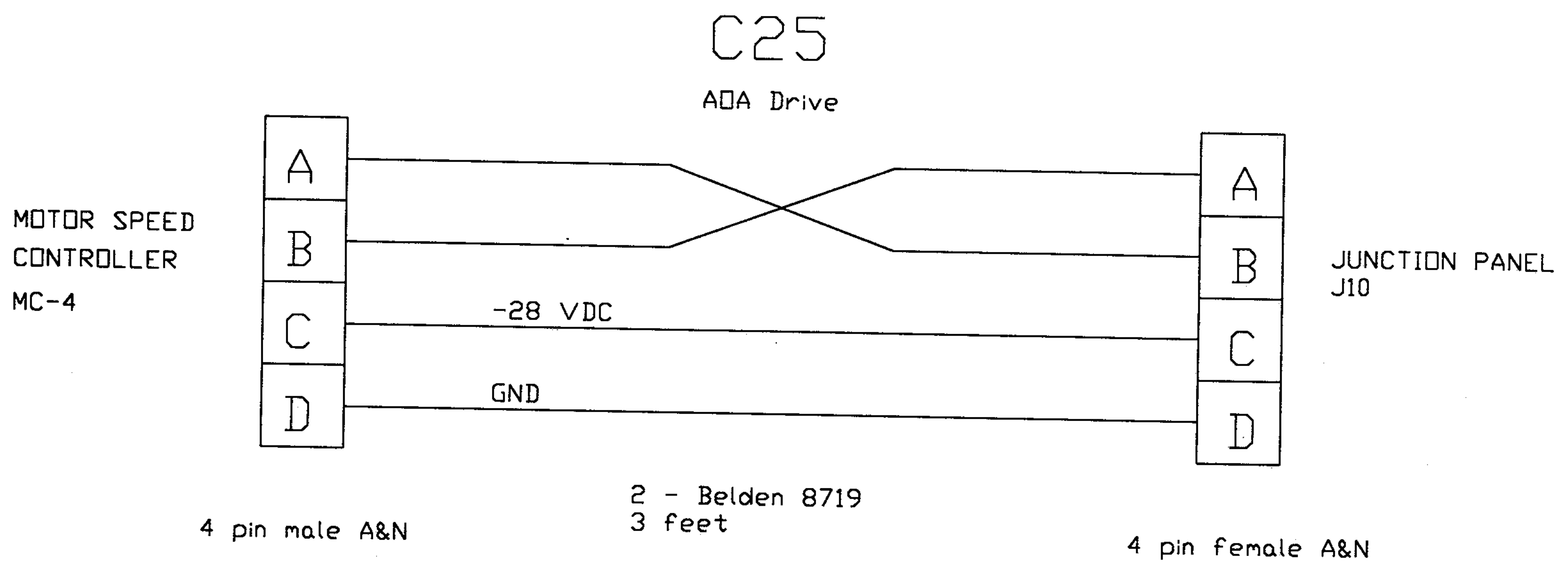
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY	
	DRAWING TITLE: CABLE C22	
	MATERIAL:	SCALE: / JO # R14303
	DRAWN BY: T. JORDAN 4713	DATE: JAN 1992



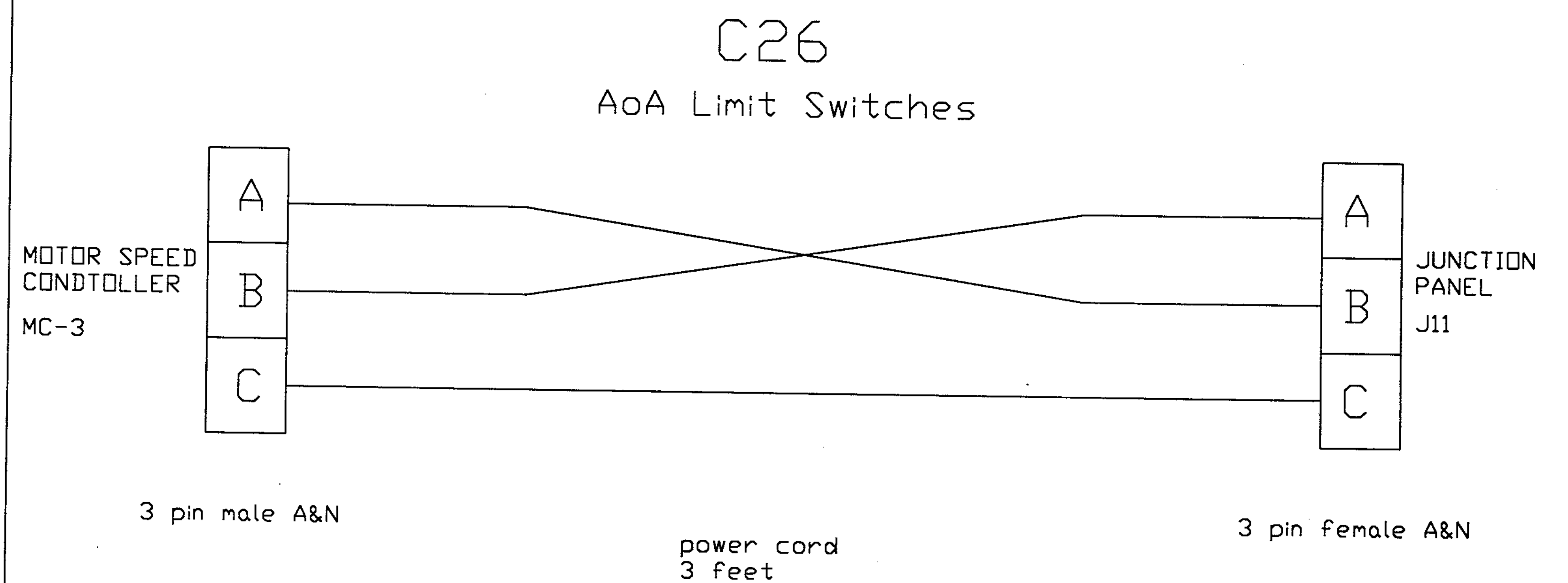
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION	PROJECT TITLE: DYNAMIC STABILITY	
LANGLEY RESEARCH CENTER	DRAWING TITLE: CABLE C23	
HAMPTON, VA 23662	MATERIAL: SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713	DATE: JAN 1992



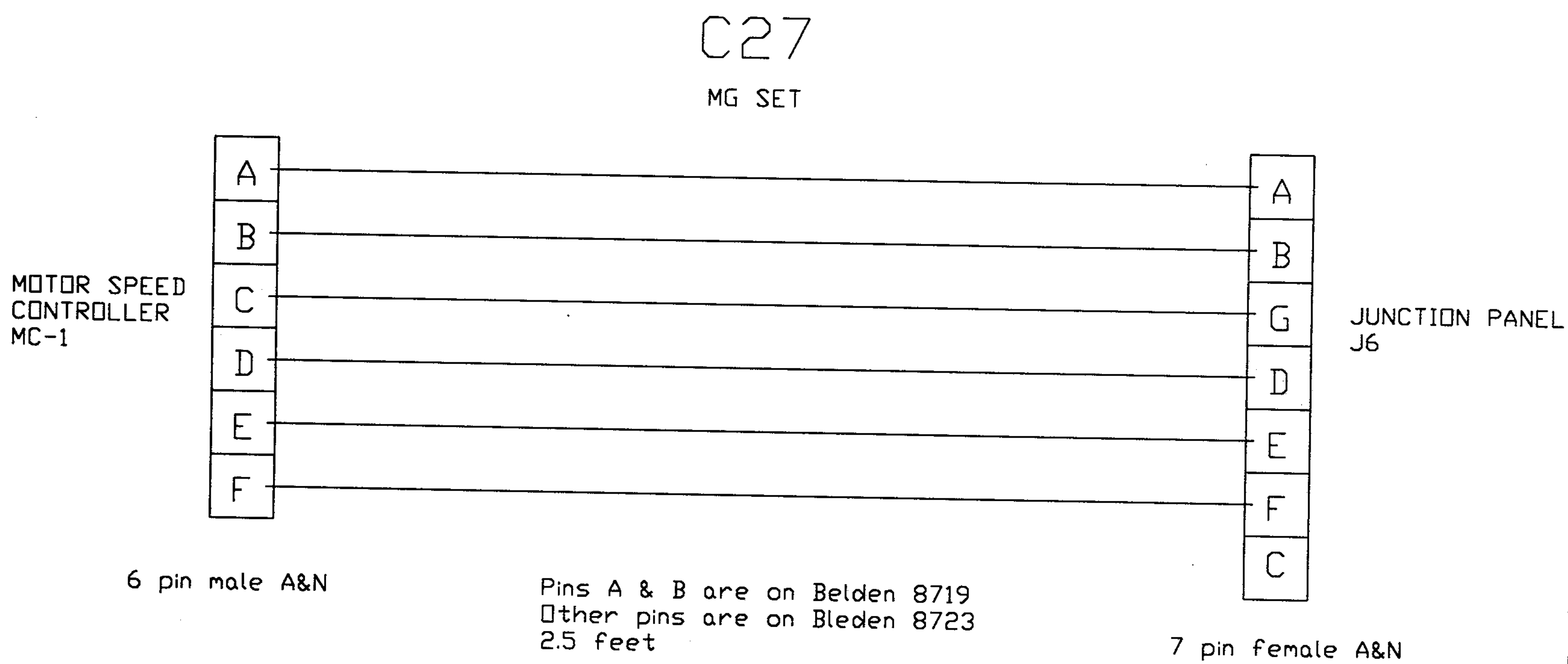
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C24		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: JAN 1992



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY DRAWING TITLE: CABLE C25 MATERIAL: / SCALE: / JO # R14303 DRAWN BY: T. JORDAN 4713 / DATE: JAN 1992

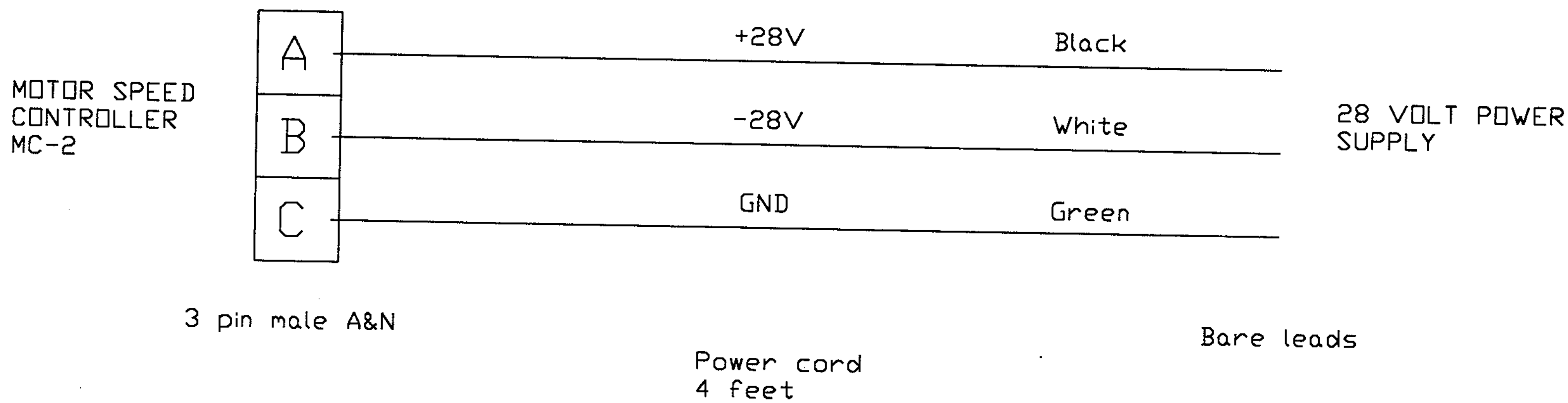


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C26		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713	DATE: JAN 1992	

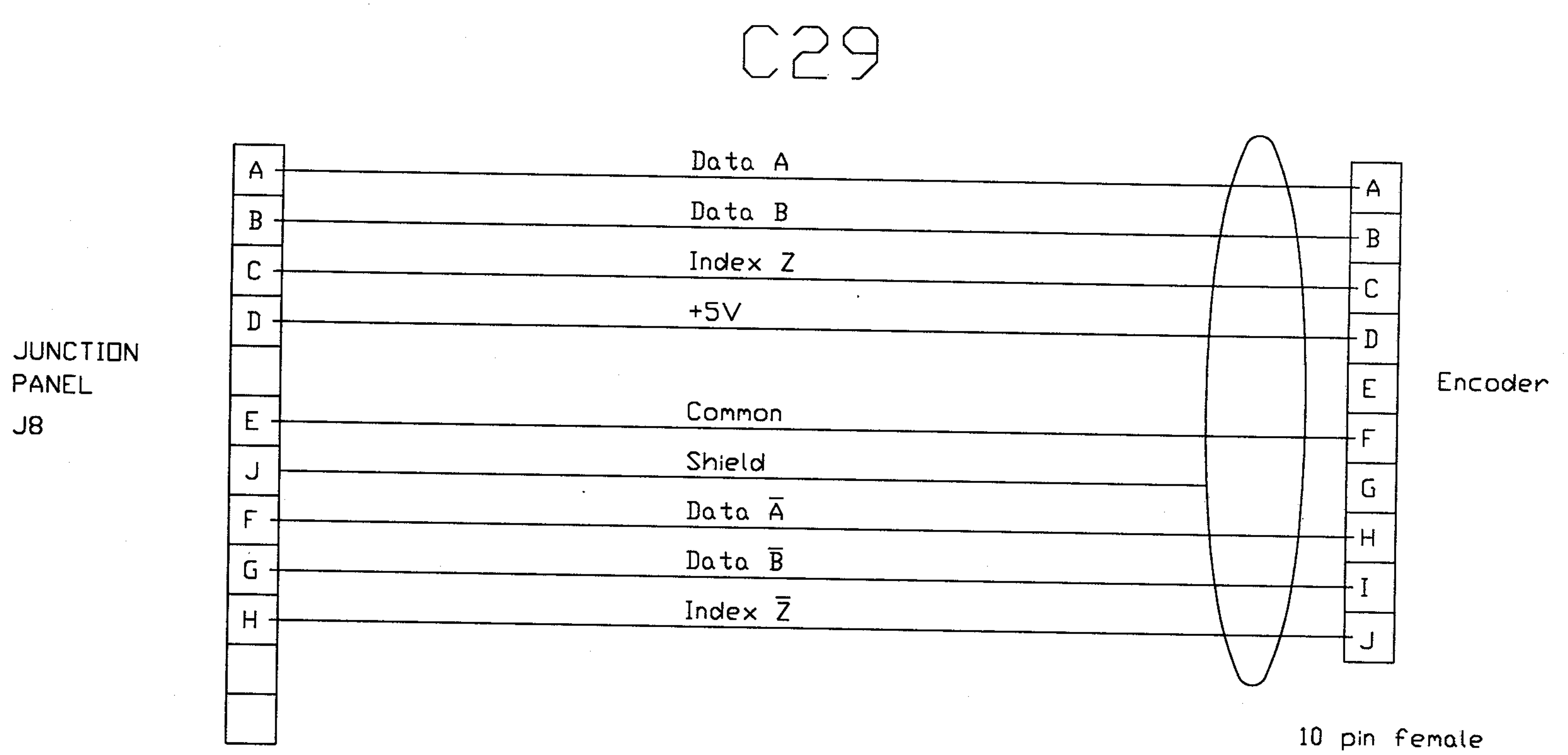


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY
	DRAWING TITLE: CABLE C27
	MATERIAL: / SCALE: / JO # R14303
	DRAWN BY: T. JORDAN 4713 / DATE: JAN 1992

C28



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C28		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: JAN 1992

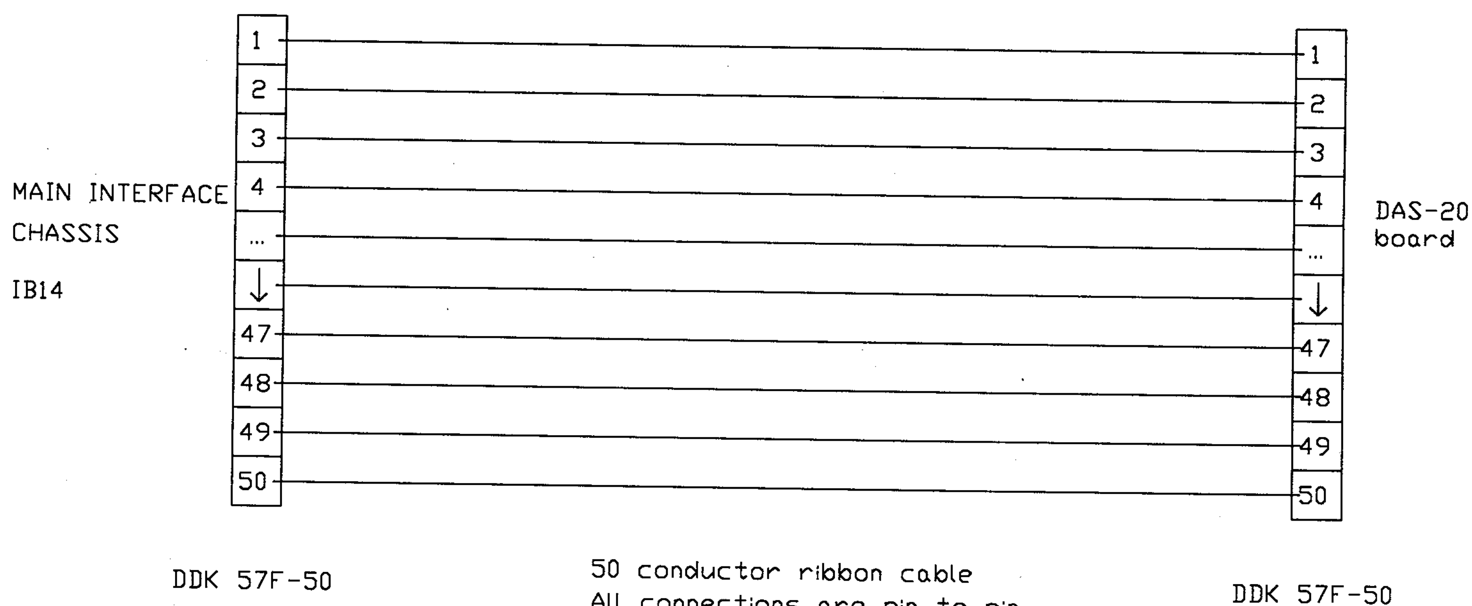


Make 1 cable 160′ long
Make 1 cable 60′ long
Alpha 5484

Note:
Use twisted pairs for the following:
(A & $\bar{A}$), (B & $\bar{B}$),
(Z & $\bar{Z}$), (+5V, Common)

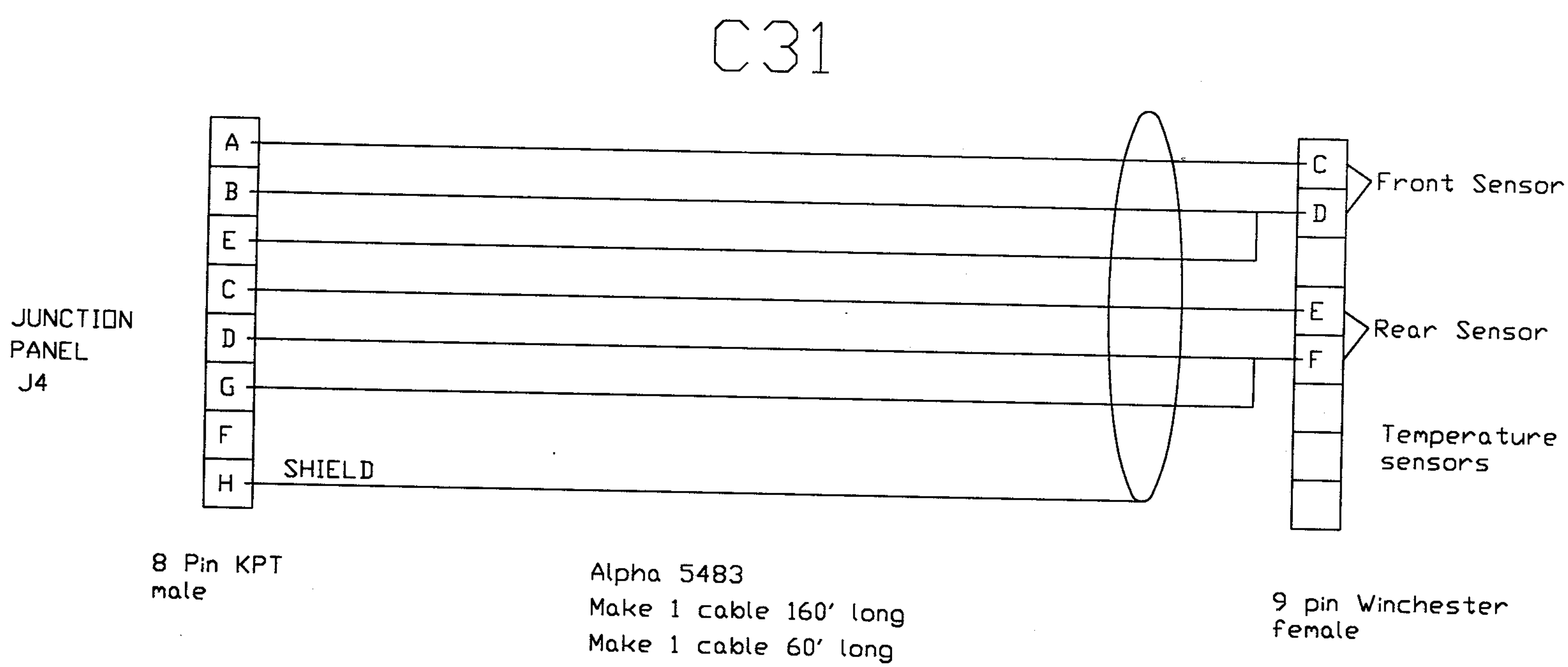
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY DRAWING TITLE: CABLE C29 MATERIAL: SCALE: JO # R14303 DRAWN BY: T. JORDAN 4713 DATE: May 1992

C30

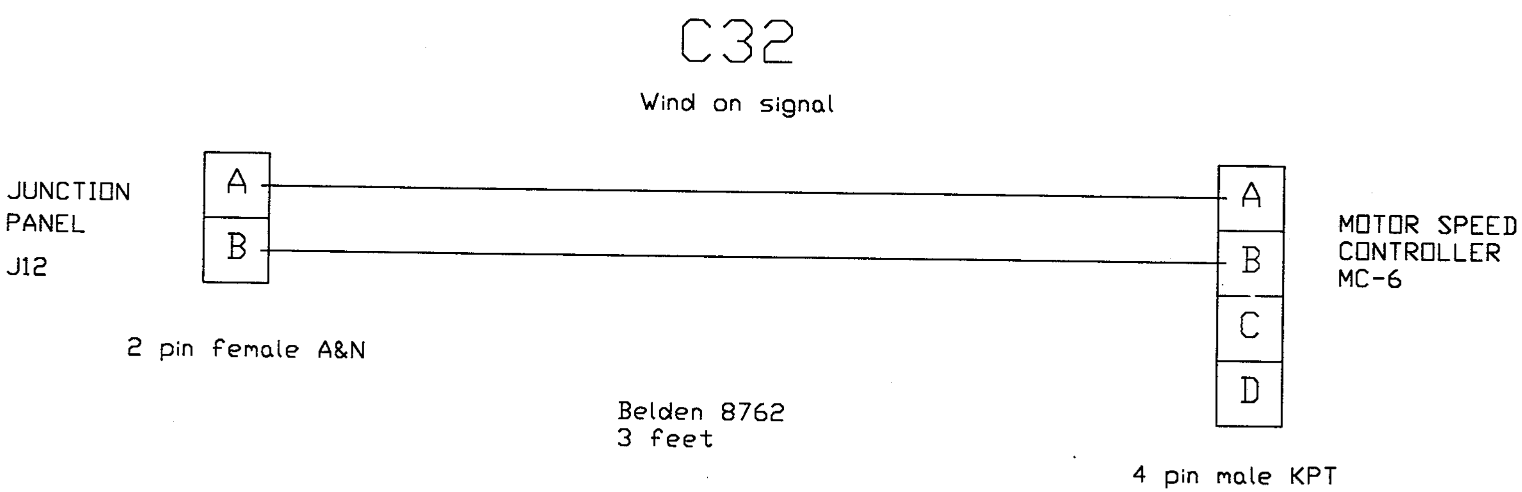


50 conductor ribbon cable
All connections are pin to pin
5 feet

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY DRAWING TITLE: CABLE C30 MATERIAL: — SCALE: — JO # R14303 DRAWN BY: T. JORDAN 4713 — DATE: JAN 1992

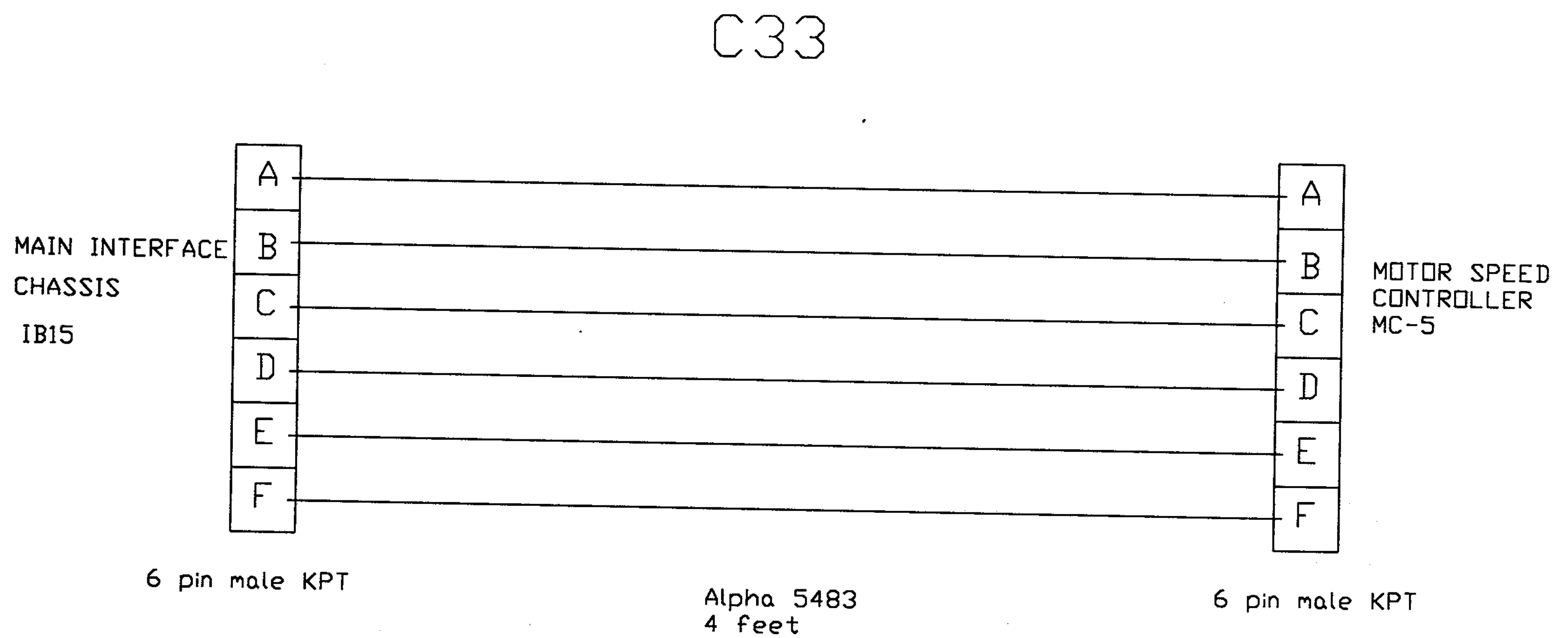


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY	
	DRAWING TITLE: CABLE C31	
	MATERIAL: SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713	DATE: MARCH 1993



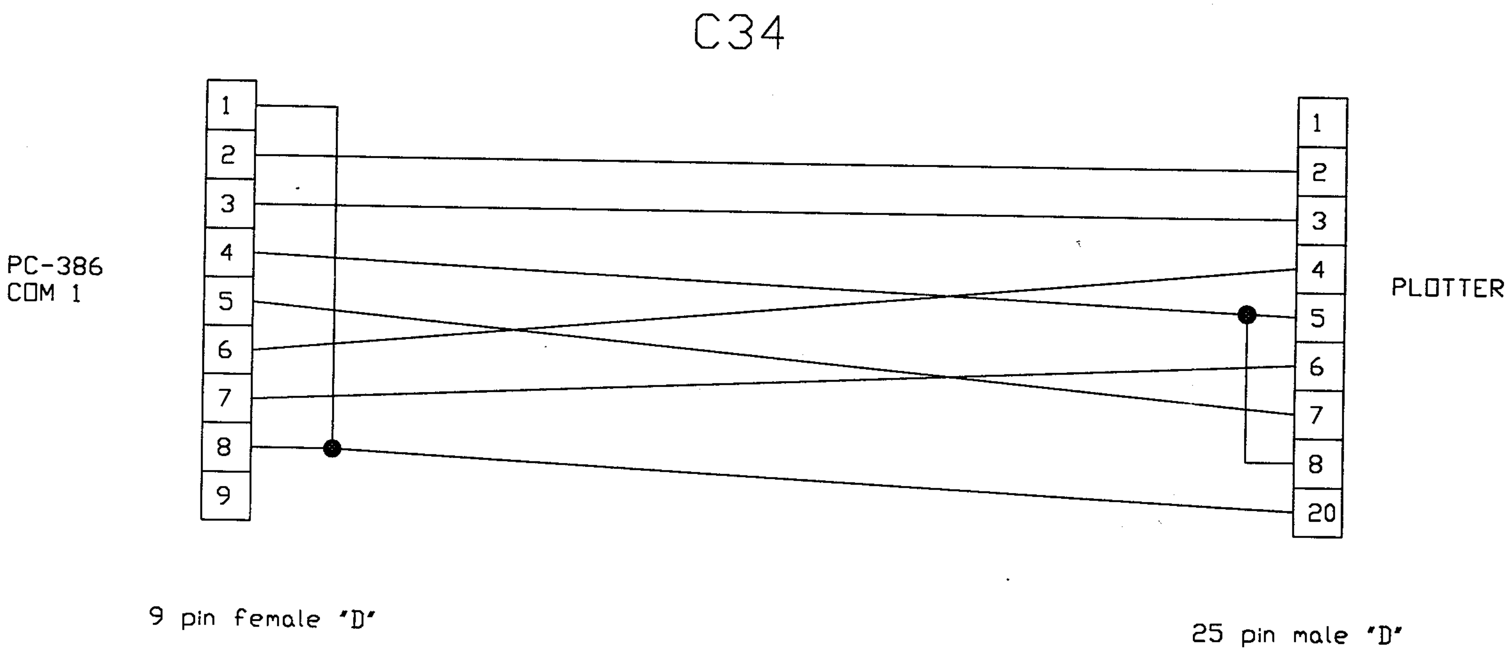
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

PROJECT TITLE: DYNAMIC STABILITY	
DRAWING TITLE: CABLE C32	
MATERIAL:	SCALE: / JO # R14303
DRAWN BY: T. JORDAN 4713	DATE: JAN 1992

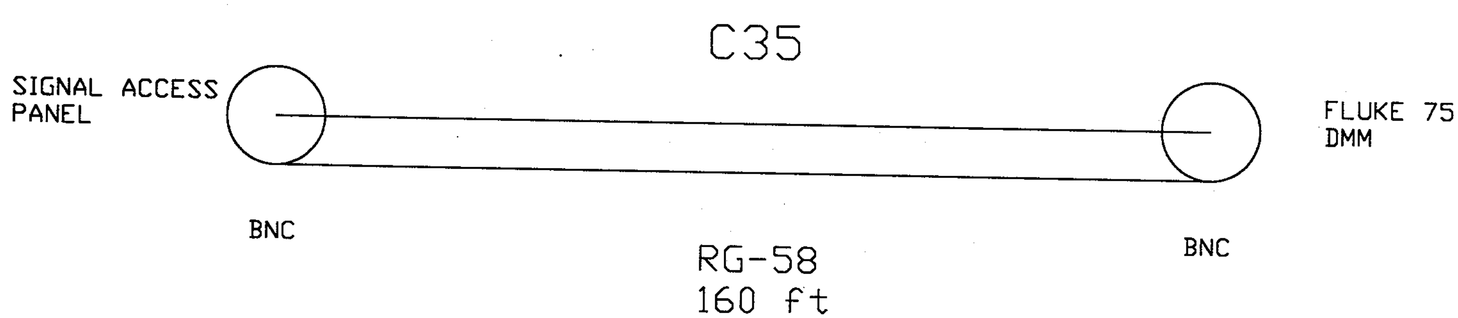


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

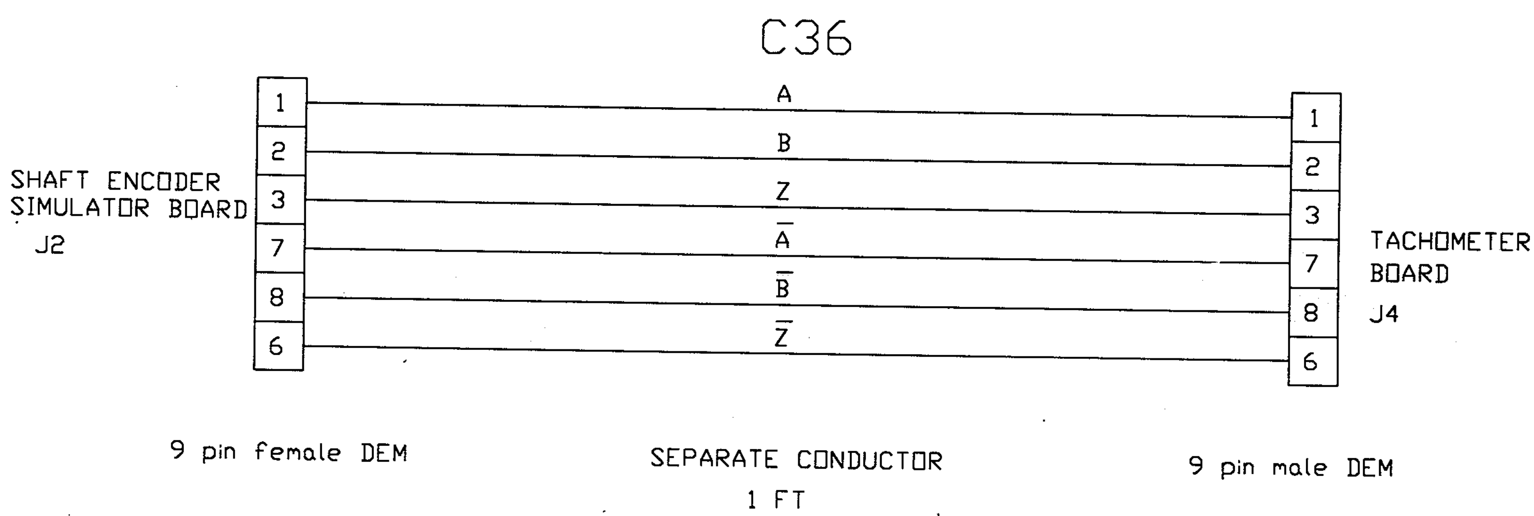
PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C33		
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713		DATE: JAN 1992



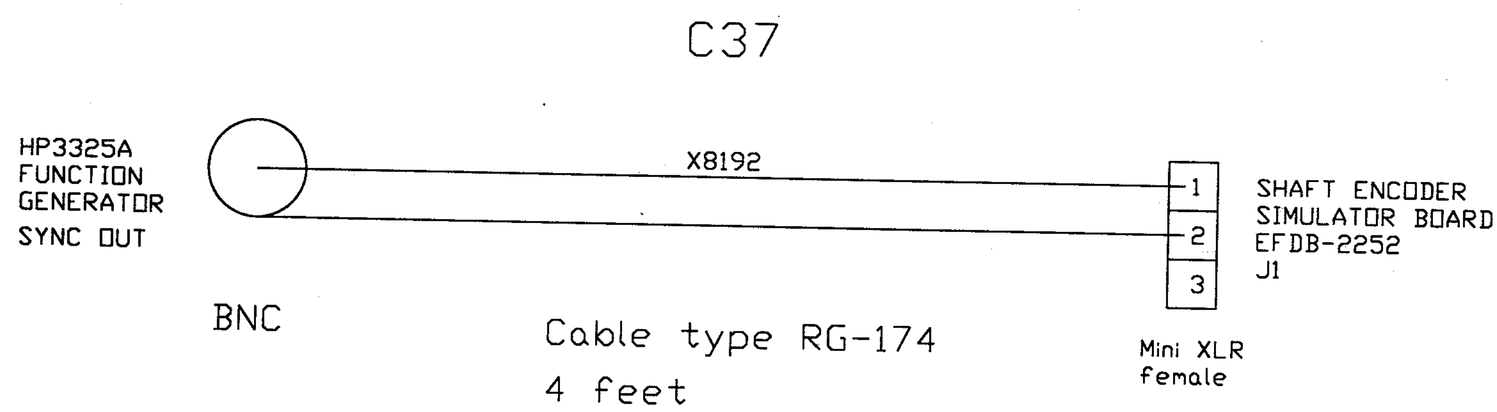
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION	PROJECT TITLE: DYNAMIC STABILITY
LANGLEY RESEARCH CENTER	DRAWING TITLE: CABLE C34
HAMPTON, VA 23662	MATERIAL: SCALE: JO # R14303
	DRAWN BY: T. JORDAN 4713 DATE: May 1992



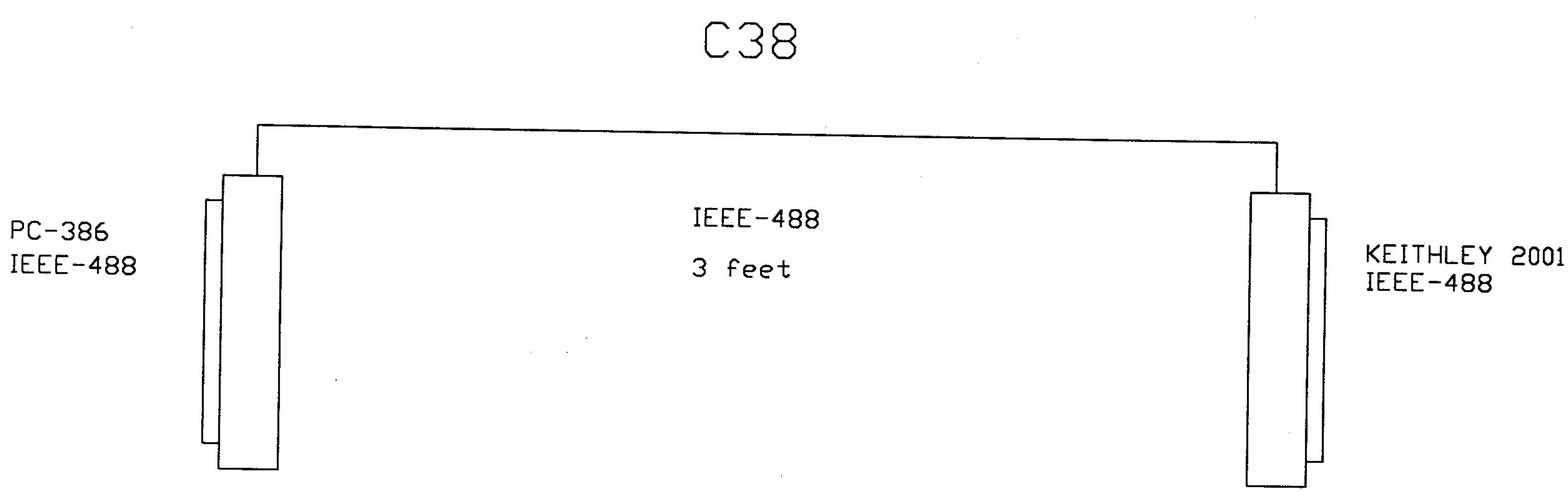
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C35		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: FEB 1993



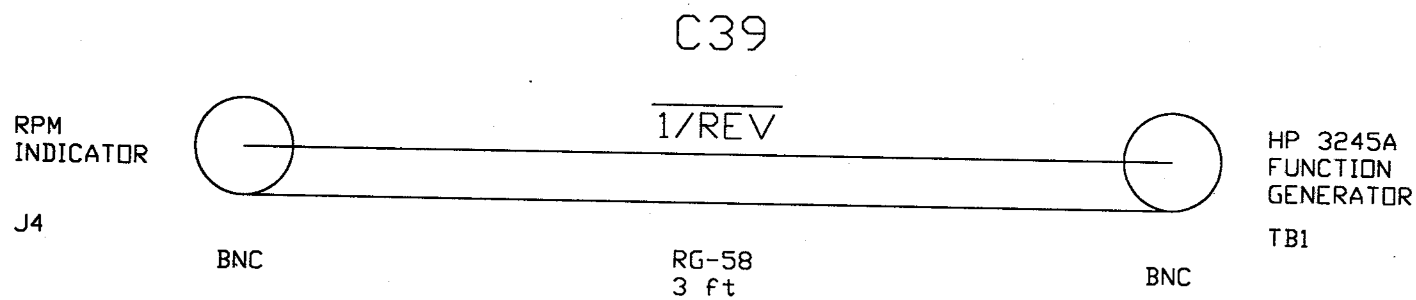
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C36		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: MARCH 1993



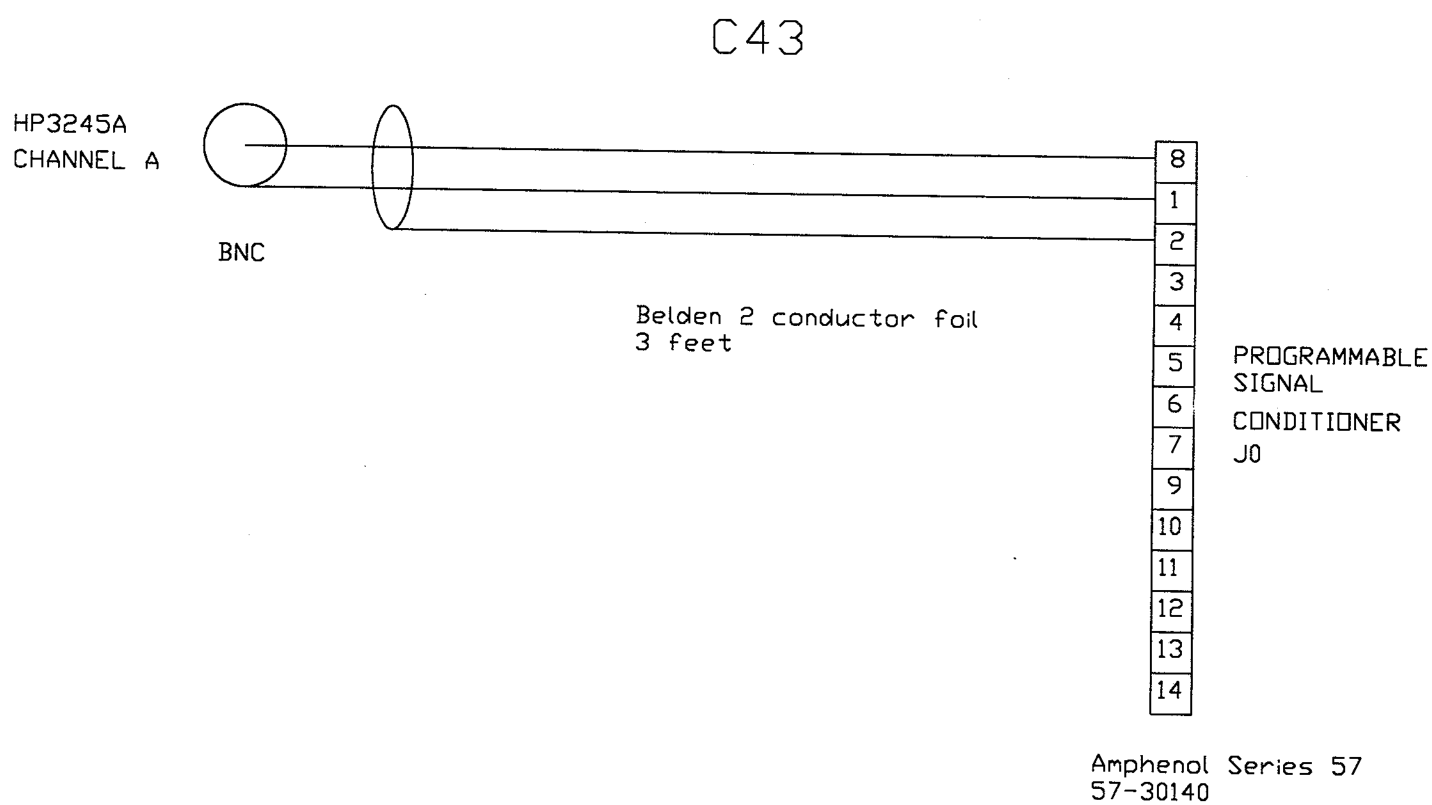
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C37		
	MATERIAL:	SCALE:	JO # R17177
	DRAWN BY: T. JORDAN 4713		DATE: FEB 1993



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY DRAWING TITLE: CABLE C38 MATERIAL: / SCALE: / JO # R14303 DRAWN BY: T. JORDAN 4713 / DATE: FEB 1993

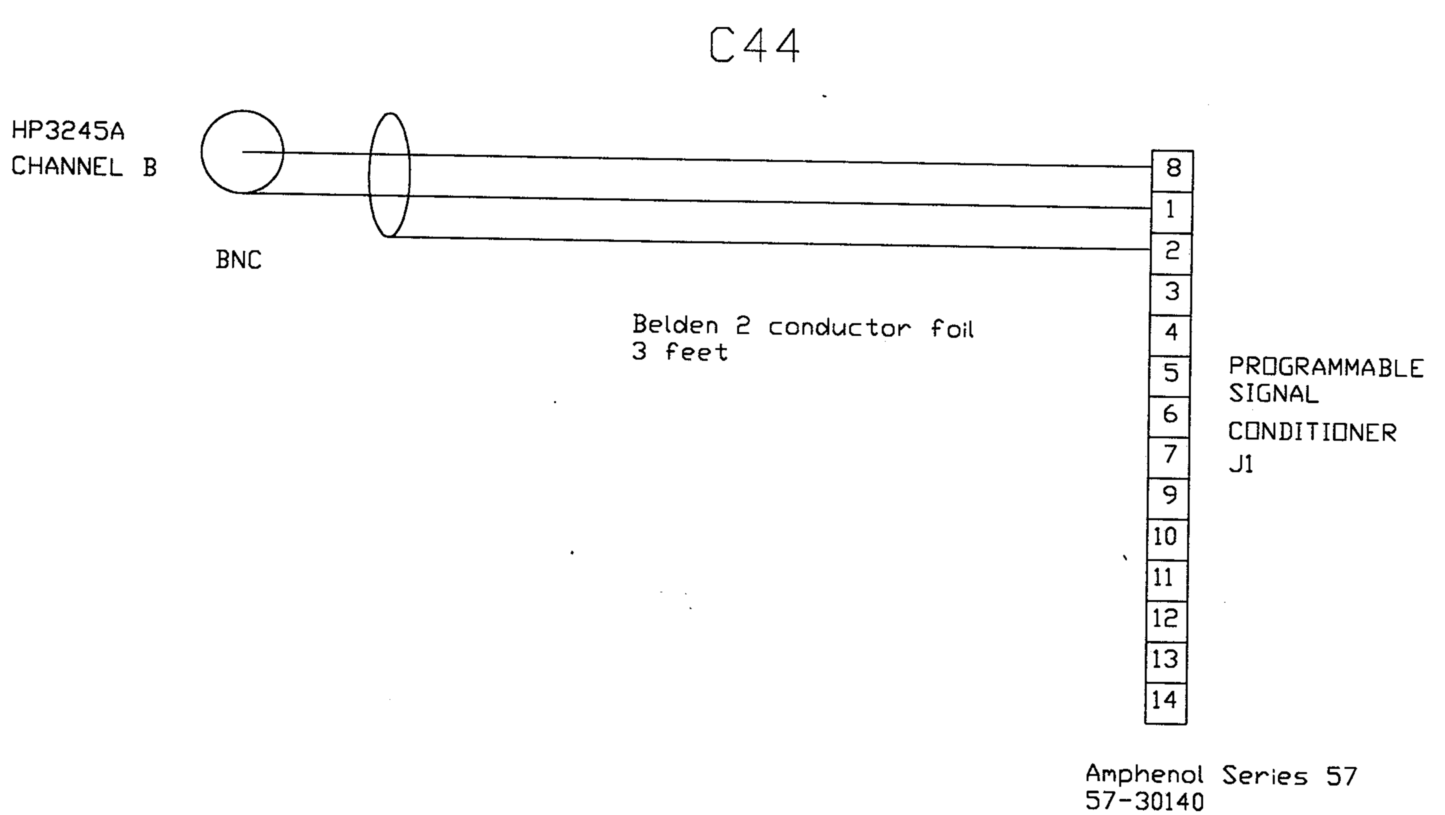


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY DRAWING TITLE: CABLE C39 MATERIAL: / SCALE: / JO # R14303 DRAWN BY: T. JORDAN 4713 / DATE: FEB 1993



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C43		
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713		DATE: FEB 1993



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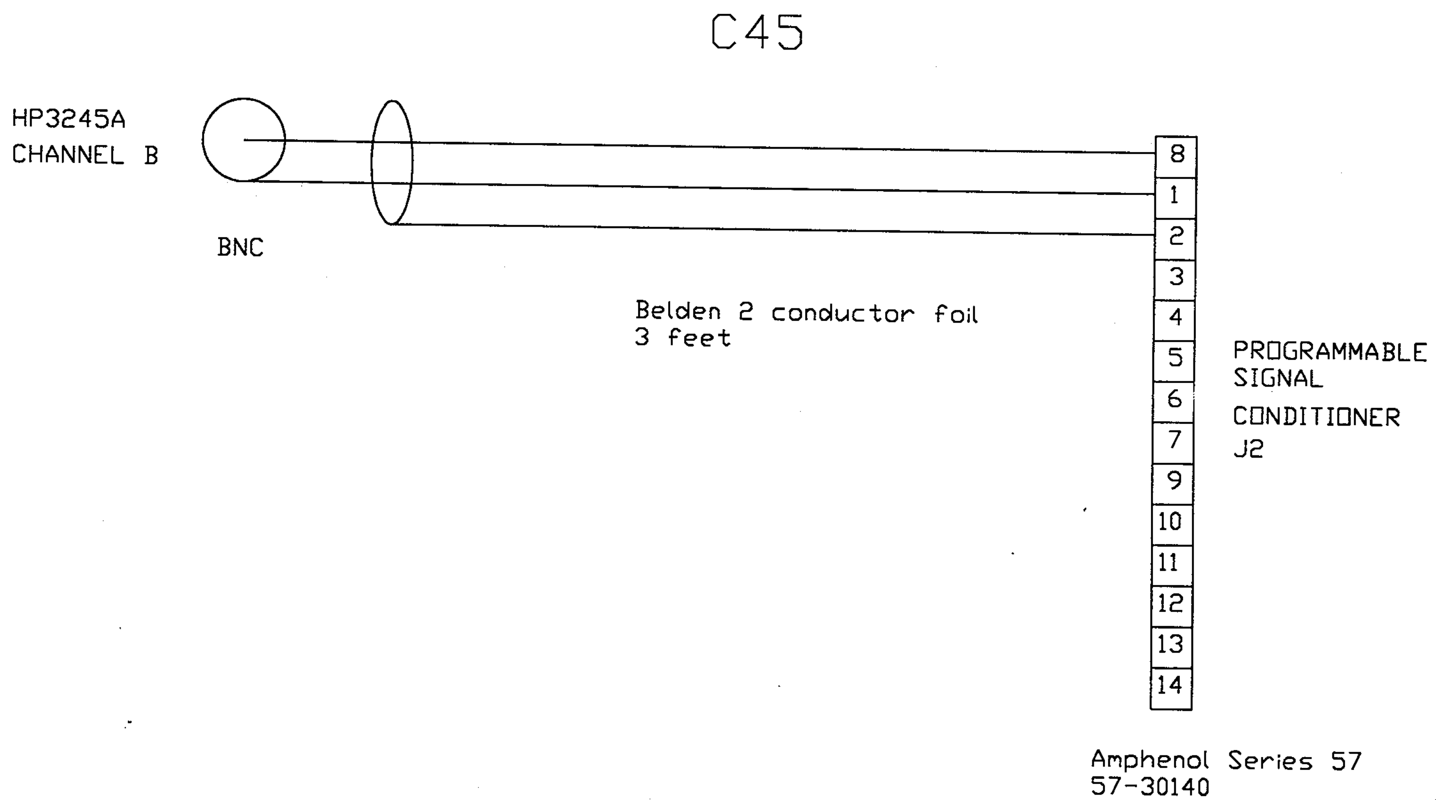
PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C44		
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713	DATE: FEB 1993	



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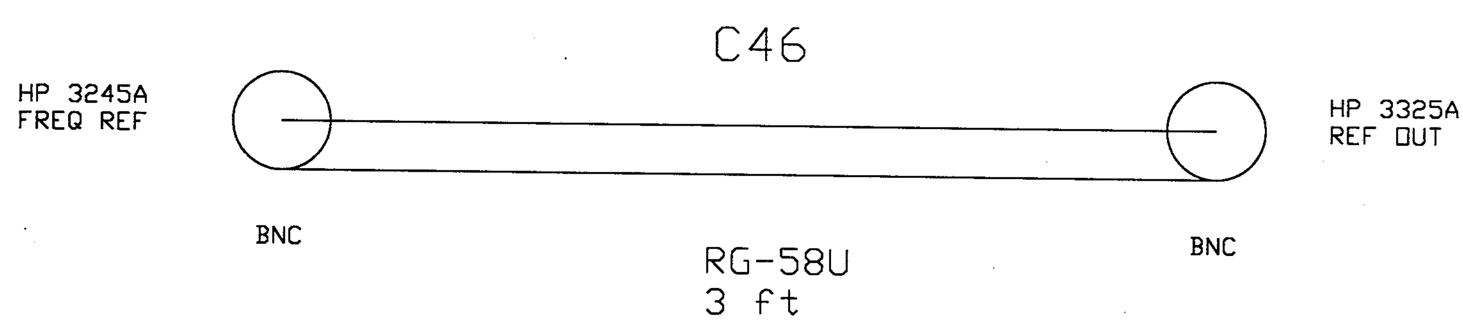
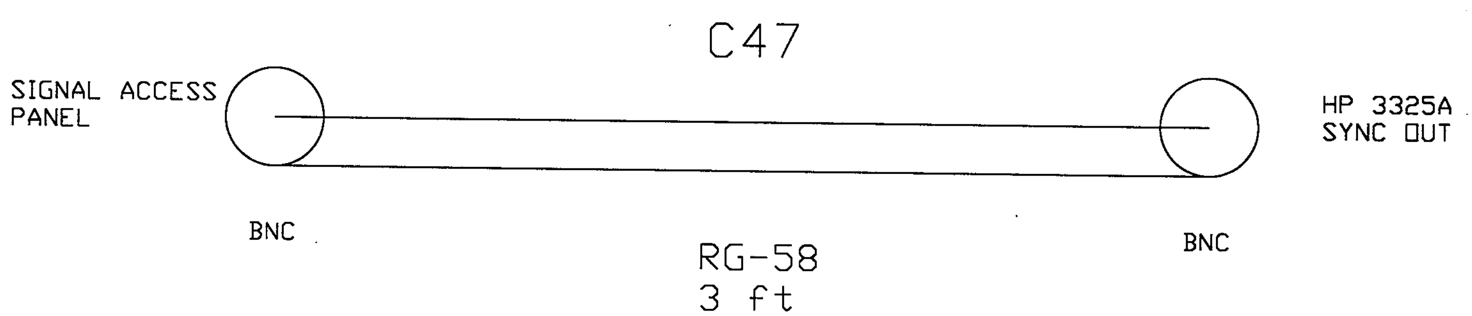
	MATERIAL:	SCALE: / JO # R14303
	DRAWN BY: T. JORDAN 4713	DATE: FEB 1993

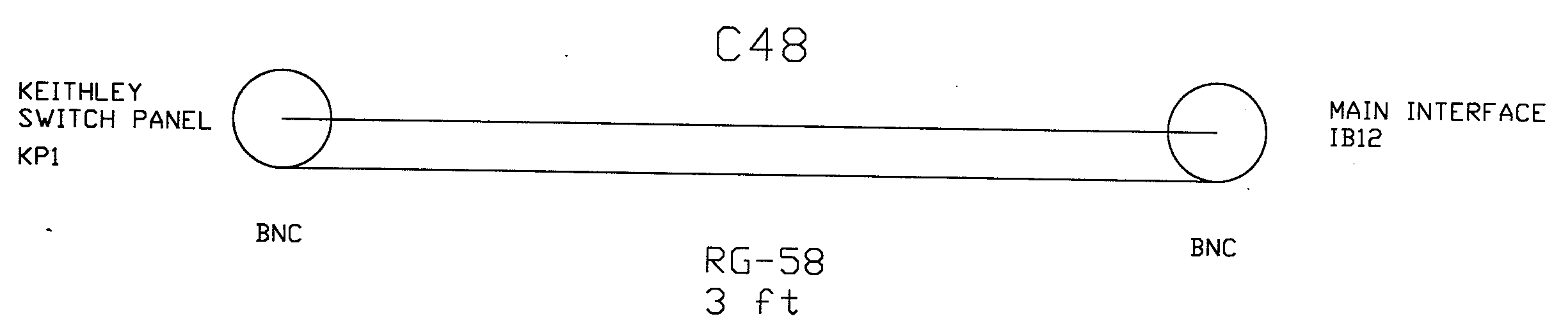


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C46		
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713		DATE: FEB 1993

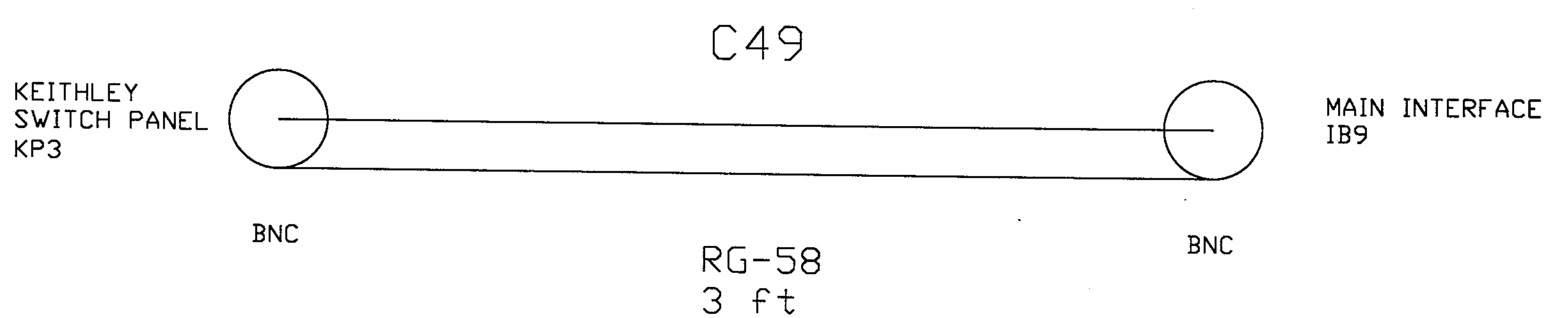


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY DRAWING TITLE: CABLE C47 MATERIAL: SCALE: JO # R14303 DRAWN BY: T. JORDAN 4713 DATE: FEB 1993



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C48		
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713	DATE: FEB 1993	



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C49		
MATERIAL:	SCALE:	JO # R14303
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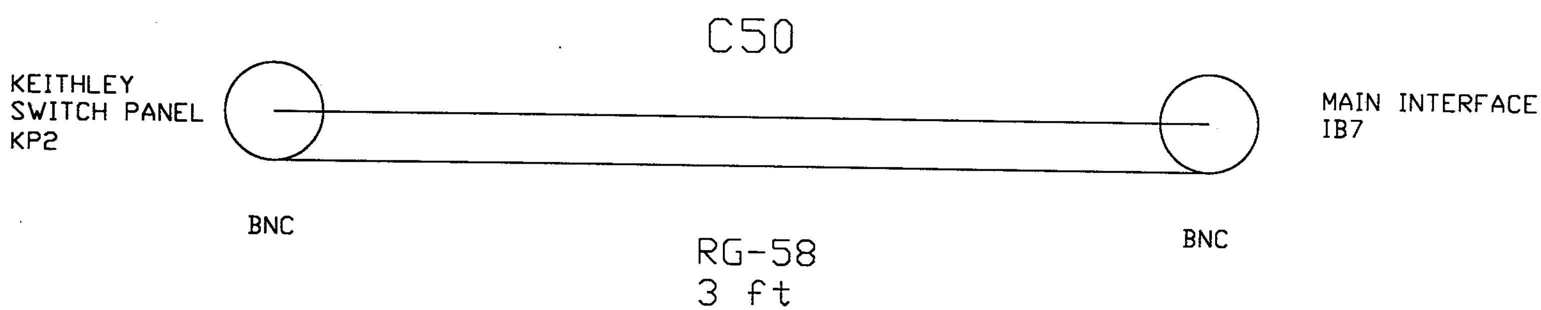

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LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

PROJECT TITLE: DYNAMIC STABILITY		
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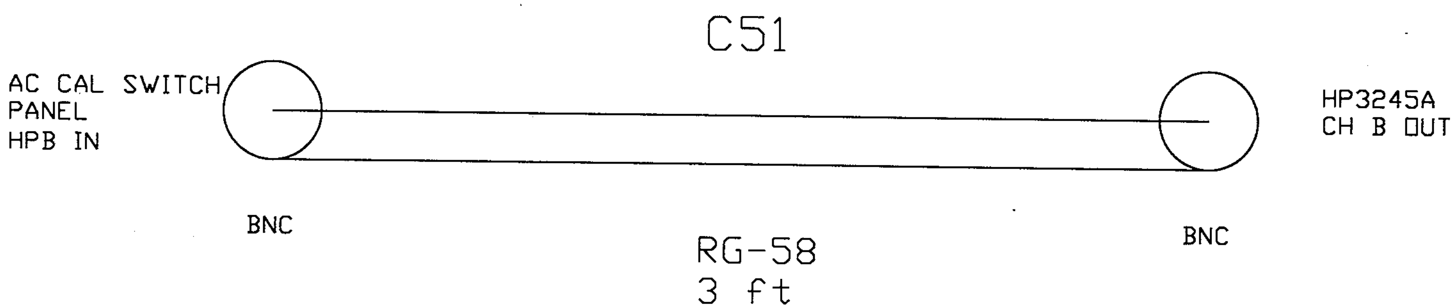
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713		DATE: FEB 1993



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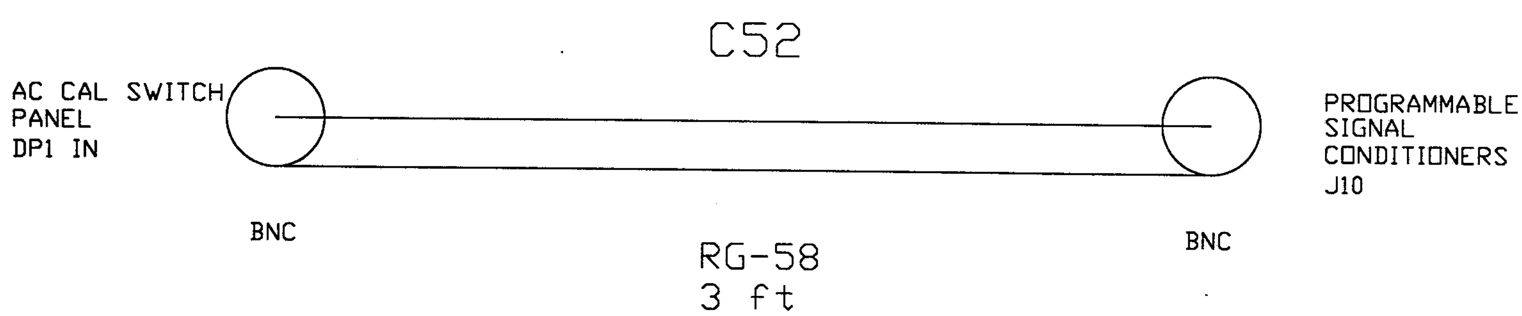
	DRAWN BY: T. JORDAN 4713		DATE: FEB 1993



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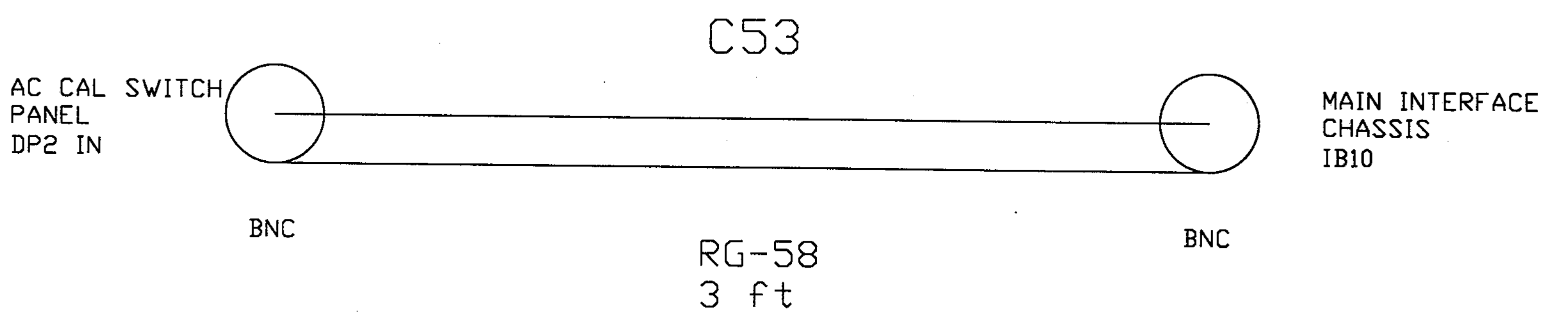
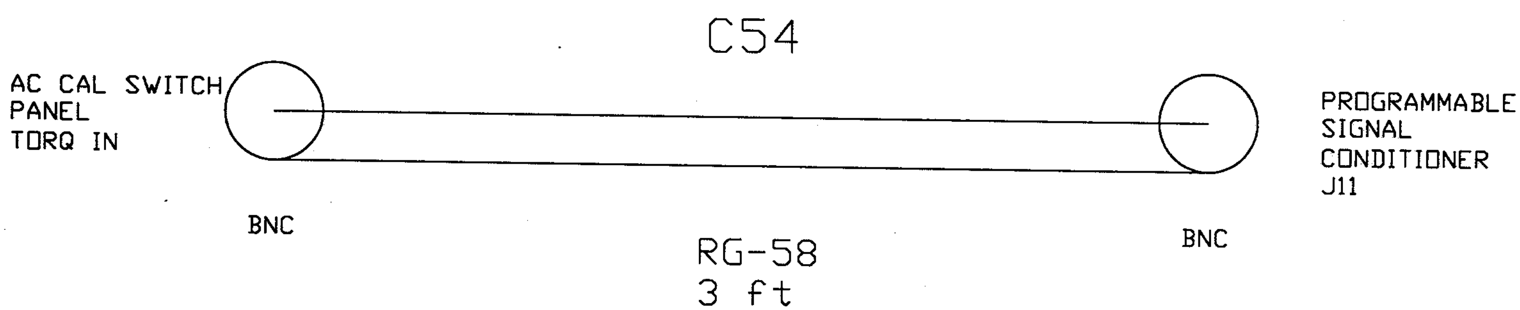
	DRAWING TITLE: CABLE C52
	MATERIAL: / SCALE: / JO # R14303
	DRAWN BY: T. JORDAN 4713 / DATE: FEB 1993

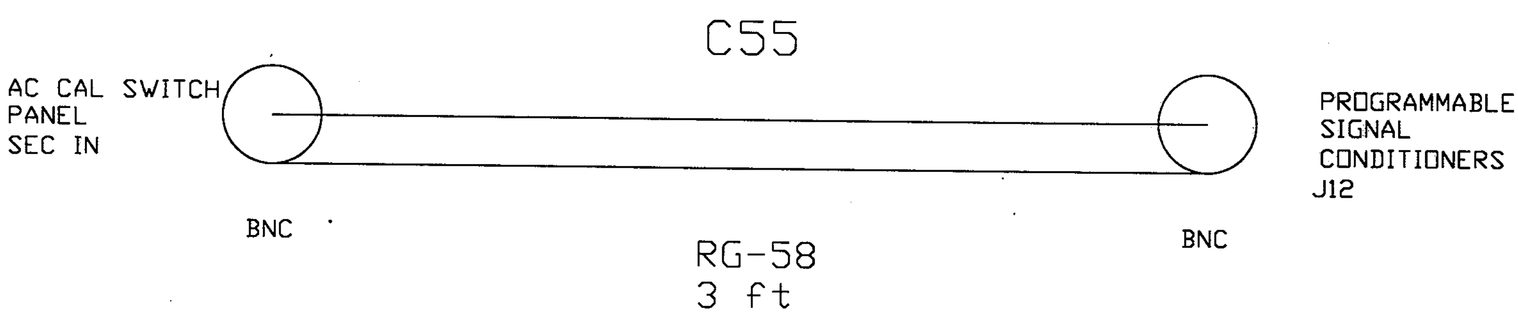


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C53		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713	DATE: FEB 1993	

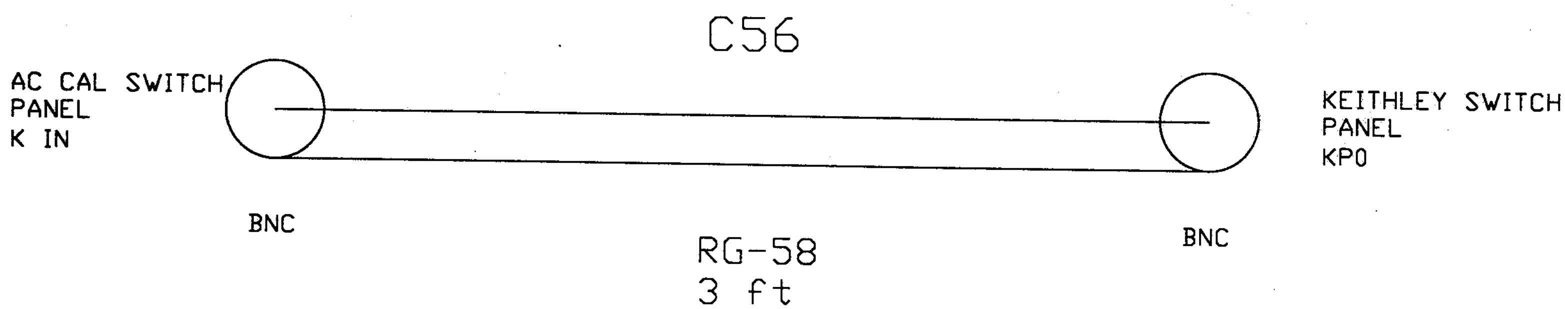


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C54		
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713	DATE: FEB 1993	



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C55		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 4713		DATE: FEB 1993



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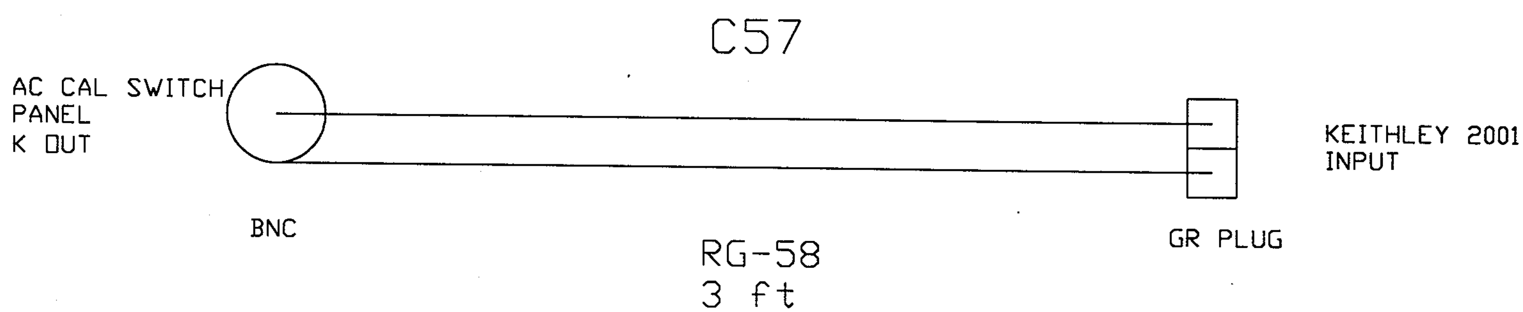
LANGLEY RESEARCH CENTER
HAMPTON, VA 23662

PROJECT TITLE: DYNAMIC STABILITY		
DRAWING TITLE: CABLE C56		
MATERIAL:	SCALE:	JO # R14303
DRAWN BY: T. JORDAN 4713		DATE: FEB 1993



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23662	PROJECT TITLE: DYNAMIC STABILITY	
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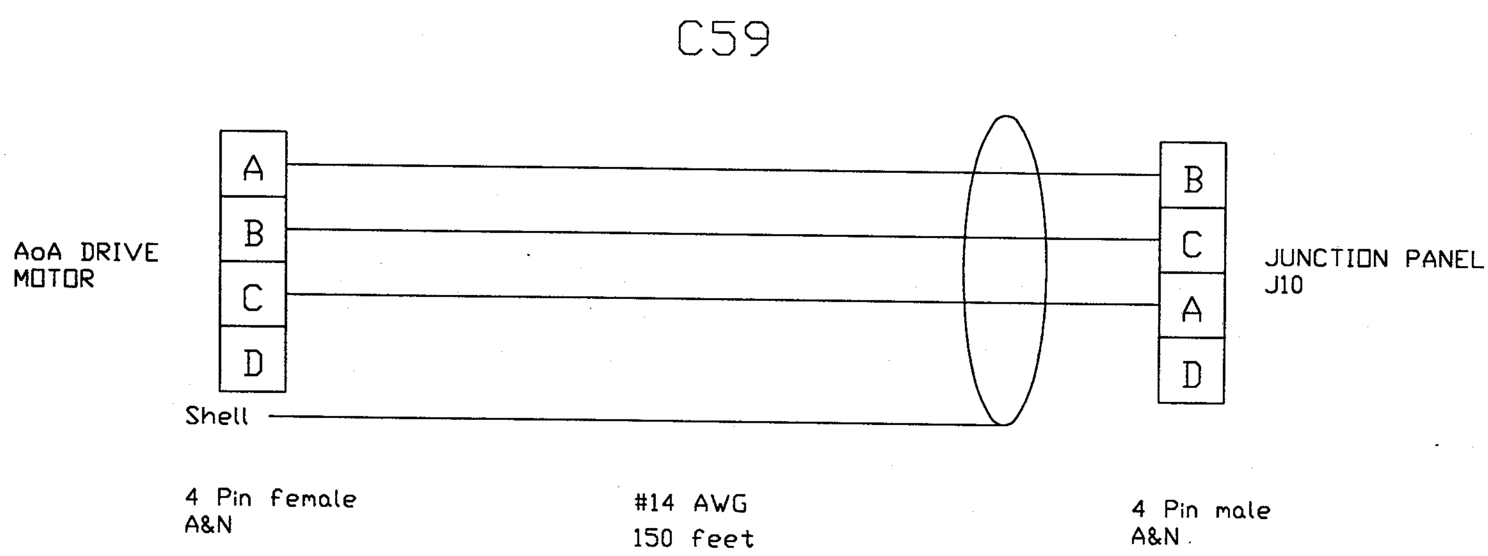
	DRAWN BY: T. JORDAN 4713	DATE: FEB 1993



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23681	PROJECT TITLE: DYNAMIC STABILITY		
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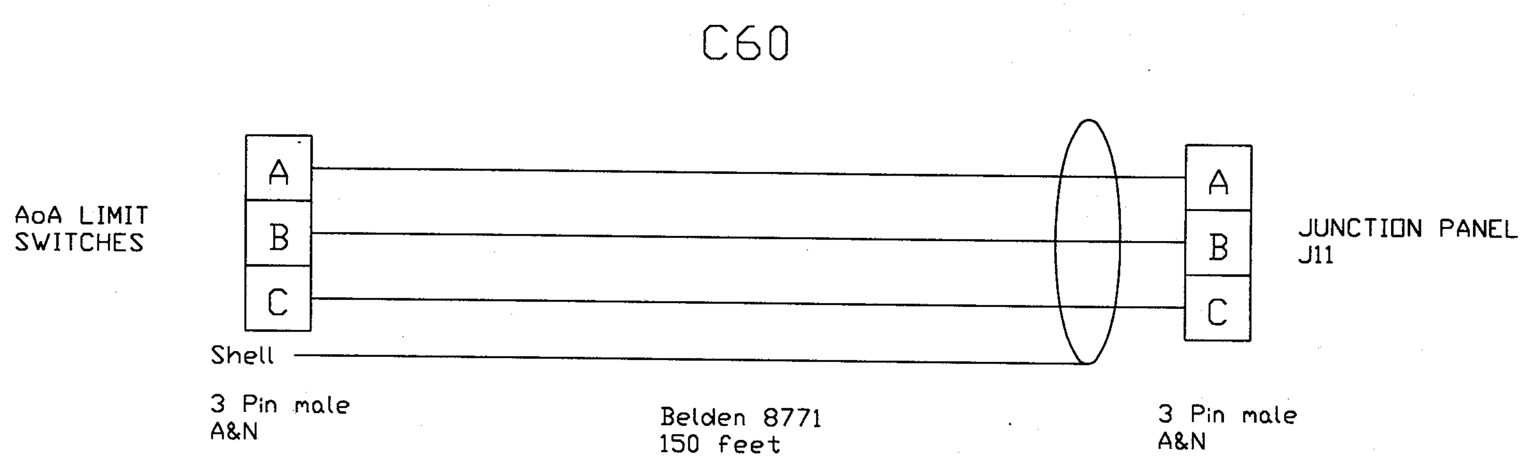
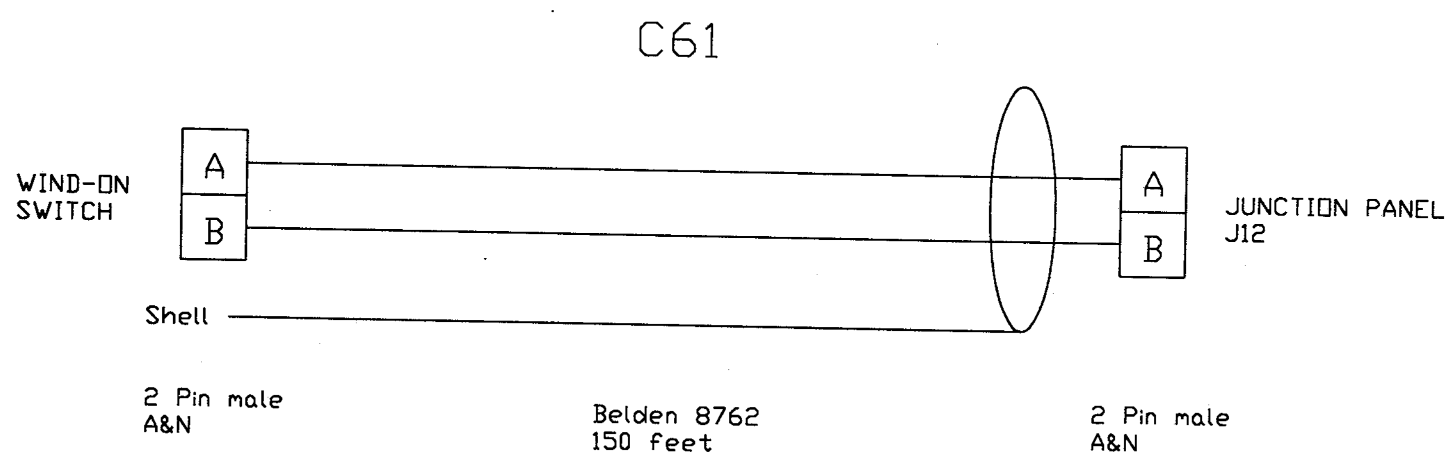
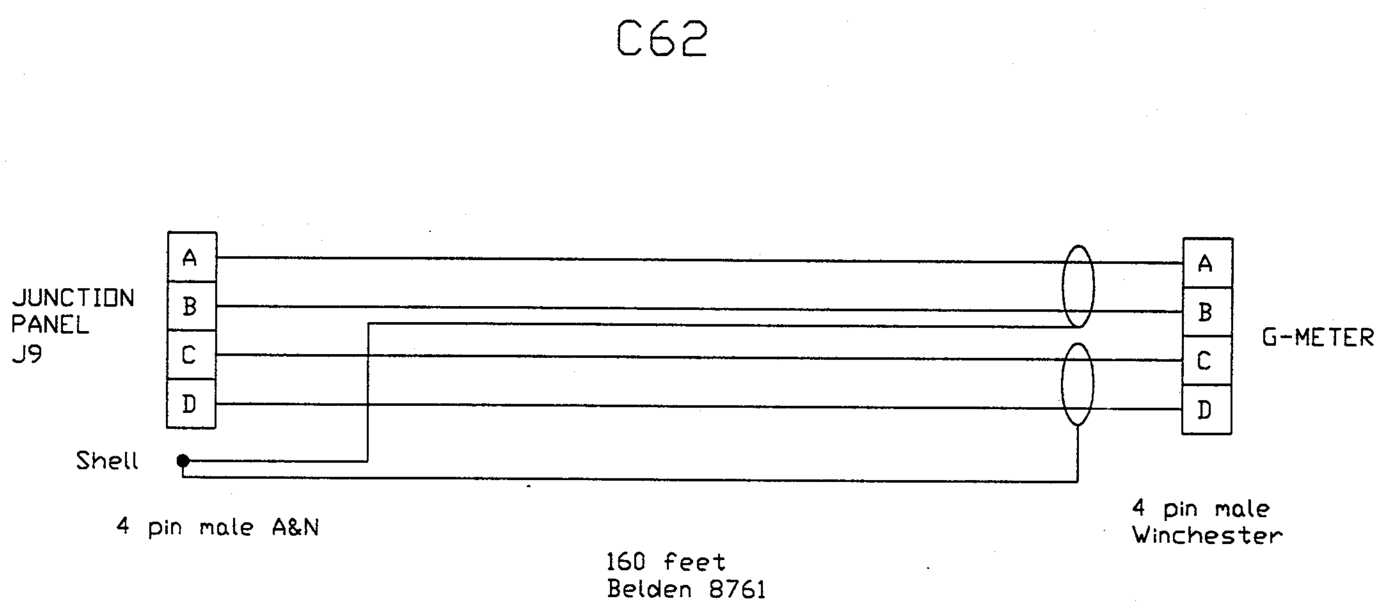
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 44713		DATE: DEC 1993



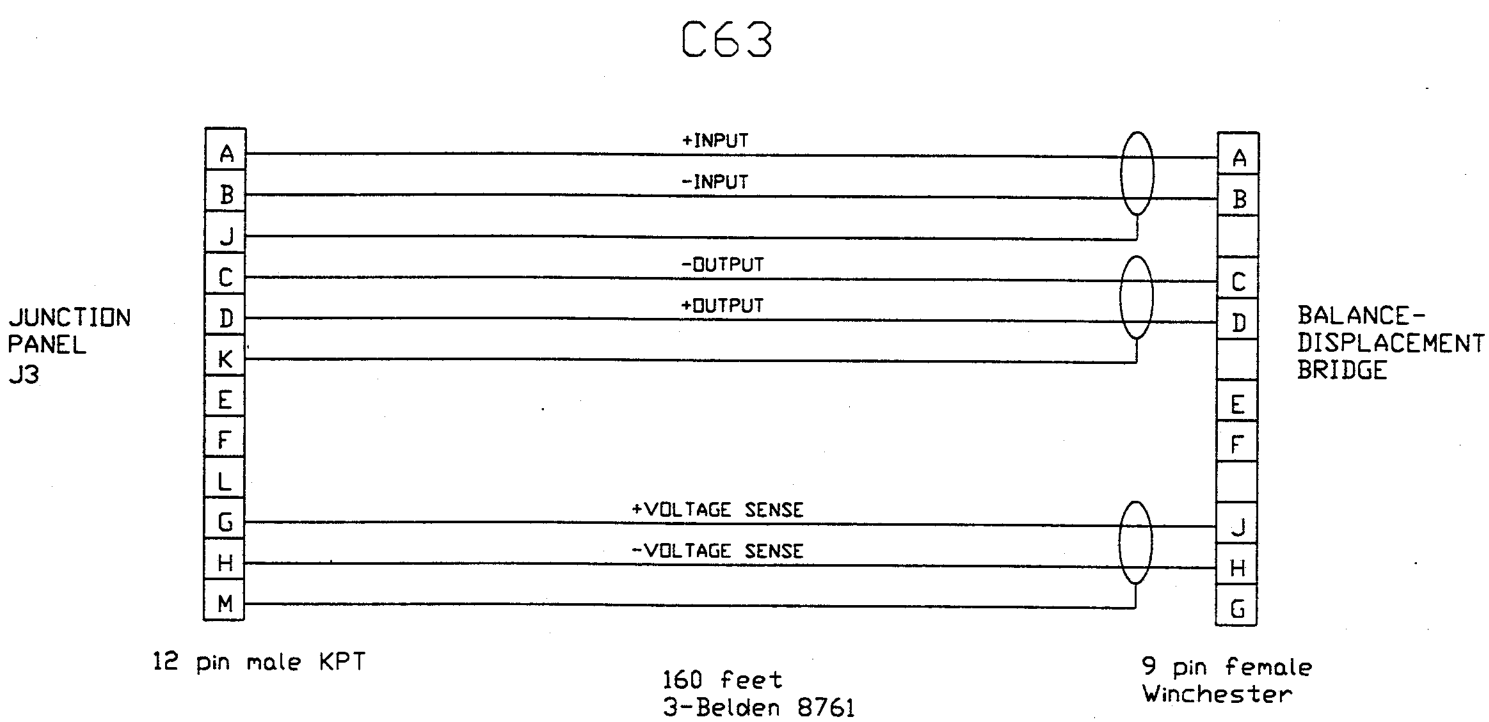
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23681	PROJECT TITLE: DYNAMIC STABILITY DRAWING TITLE: CABLE C60 MATERIAL: SCALE: JO # R14303 DRAWN BY: T. JORDAN 44713 DATE: DEC 1993



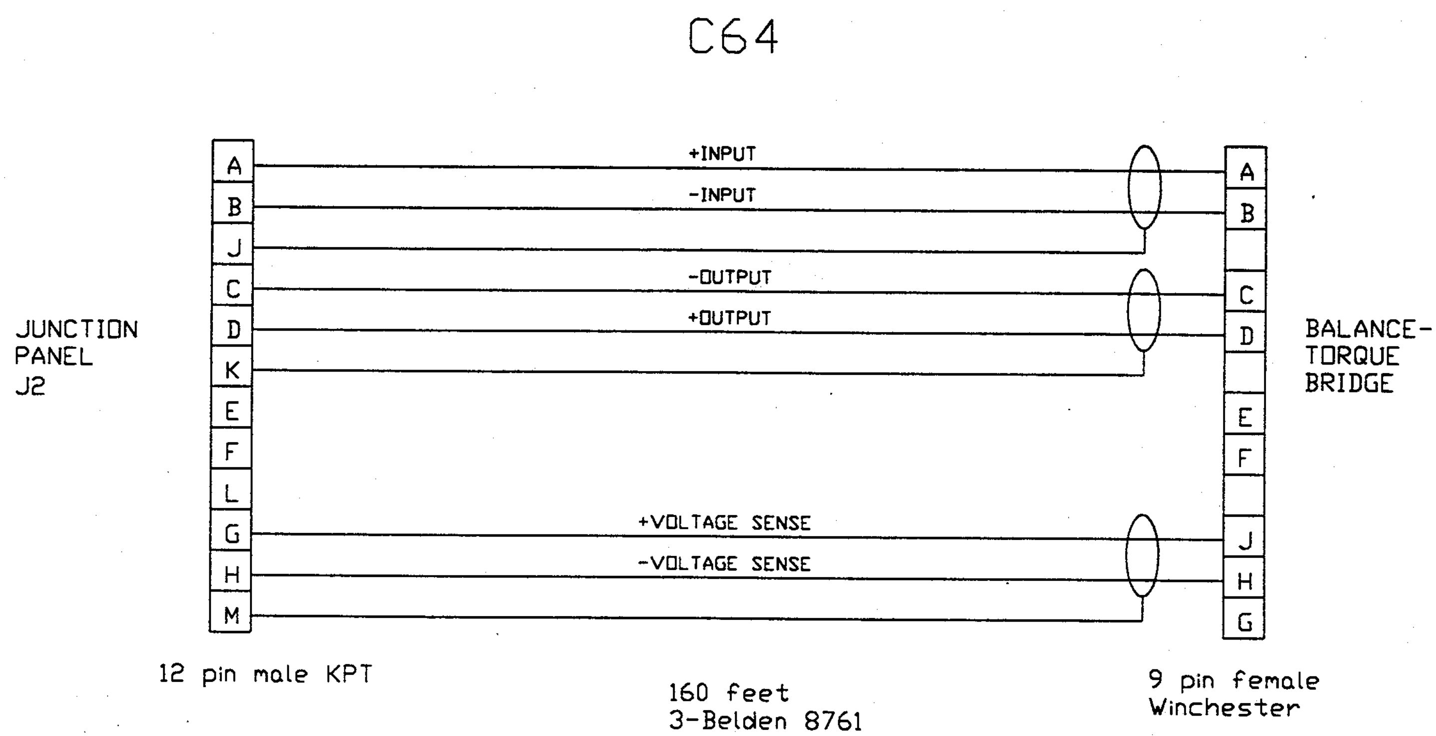
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23681	PROJECT TITLE: DYNAMIC STABILITY	
	DRAWING TITLE: CABLE C61	
	MATERIAL: | SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 44713	DATE: DEC 1993



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23681	PROJECT TITLE: DYNAMIC STABILITY DRAWING TITLE: CABLE C62 MATERIAL: SCALE: JO # R14303 DRAWN BY: T. JORDAN 44713 DATE: DEC 1993

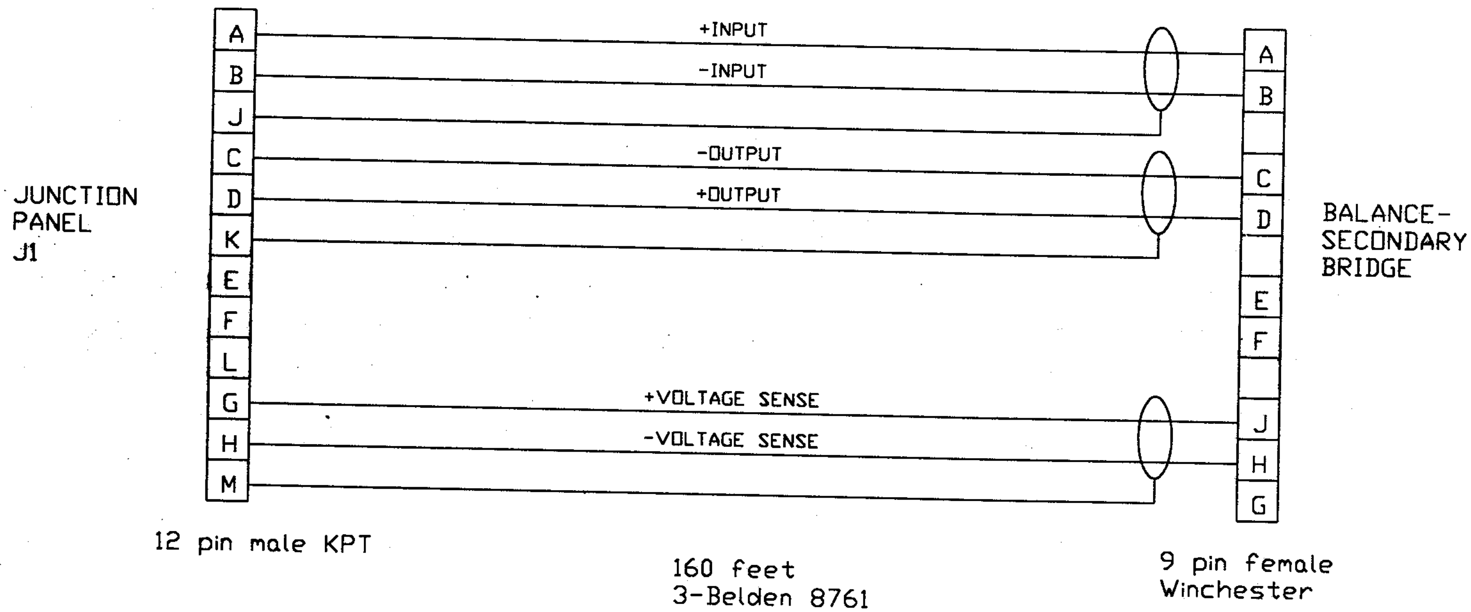


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23681	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C63		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 44713		DATE: DEC 1993



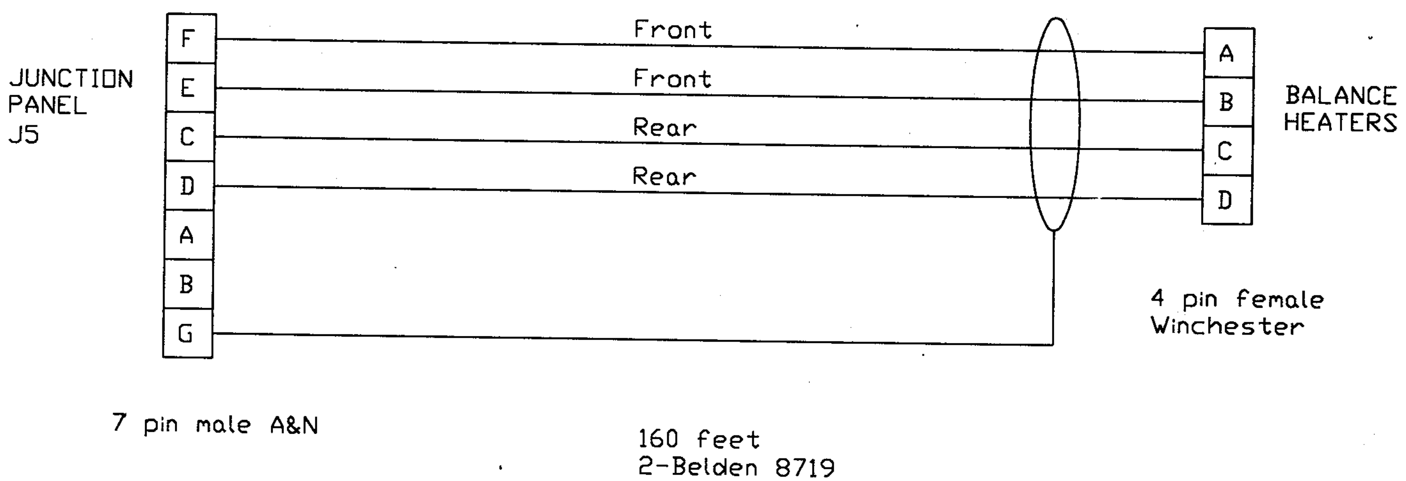
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23681	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C64		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 44713		DATE: DEC 1993

C65



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23681	PROJECT TITLE: DYNAMIC STABILITY		
	DRAWING TITLE: CABLE C65		
	MATERIAL:	SCALE:	JO # R14303
	DRAWN BY: T. JORDAN 44713	DATE: DEC 1993	

C66



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23681	PROJECT TITLE: DYNAMIC STABILITY		
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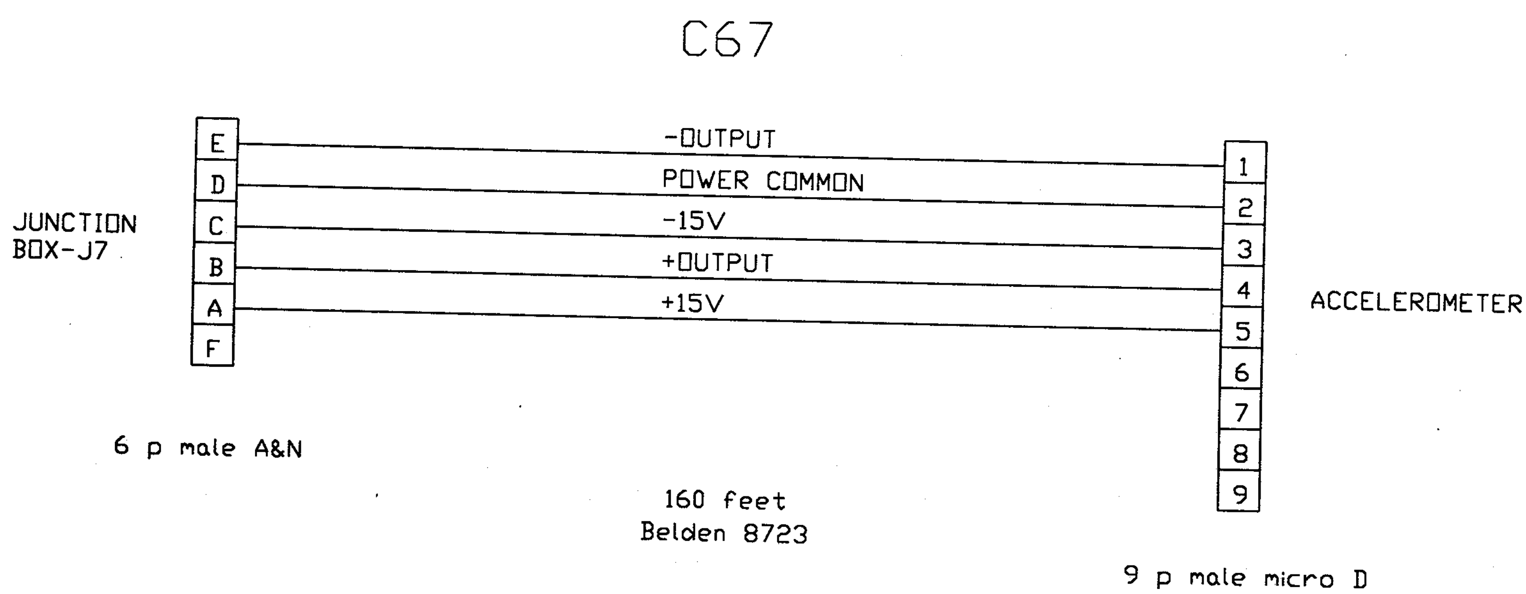
	DRAWN BY: T. JORDAN 44713		DATE: DEC 1993



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER HAMPTON, VA 23681	PROJECT TITLE: DYNAMIC STABILITY DRAWING TITLE: CABLE C67 MATERIAL: SCALE: JO # R14303 DRAWN BY: T. JORDAN 44713 DATE: DEC 1993

Tables

Table 1. PC Internal Boards

PC Backplane Slot	Board Type	Principle Function
1	Blank	N/A
2	HD/FD Controller	Hard Drive Control
3	Serial Port	Communications
4	Blank	N/A
5	Shaft Encoder Simulator Board	Calibration
6	Tachometer Board	Measure Balance Oscillation Frequency
7	Blank	N/A
8	DSP #1	Sample and Process Data
9	DSP #2	"
10	Blank	N/A
11	80386 CPU Board	PC
12	VGA Display Adapter	Monitor
13	IEEE-488	Process Control
14	DAS-20	I/O Functions

Table 2. Junction Panel Connectors

Connector #	Signal	Connector Type
J1	Displacement	12 Pin Female KPT
J2	Torque	12 Pin Female KPT
J3	Secondary	12 Pin Female KPT
J4	Temperature Sensors	8 Pin Female KPT
J5	Heaters	7 Pin Female A&N
J6	Motor-Generator Set	7 Pin Female A&N
J7	Q-FLEX	6 Pin Female A&N
J8	Encoder	12 Pin Female KPT
J9	G-Meter	4 Pin Female A&N
J10	AoA Motor	4 Pin Female A&N
J11	AoA Limit Switches	3 Pin Female A&N
J12	Wind-On Switch	2 Pin Female A&N

Table 3. Shunt Resistors

Shunt Pair	Value (Ohms)	Calibrate Signal (millivolts)
1	50K	17.4
2	100K	8.7
3	150K	5.8
4	200K	4.4

Table 4. Data Code Descriptions

Data code	Data Type
1	Calibration Zero
9	Calibration Data
2	Tare Zero
3	Tare Data
6	Wind-On Zero
7	Wind-On Data

Table 5. Component Power in DSIS Rack

Component	AC Type
Heater Controllers	Unregulated
Oscilloscope	Unregulated
Rack Fan #1 & #2	Unregulated
40 VDC Power Supply	Unregulated
XY Plotter	Unregulated
AC Regulator	Unregulated
LaserJet II Printer	Unregulated
PC-386	Regulated
Programmable Signal Conditioners	Regulated
Q-FLEX Chassis	Regulated
Motor Speed Controller and Data Code Display	Regulated
Main Interface Chassis	Regulated
HP3245A Function Generator	Regulated
HP3325A Function Generator	Regulated
Keithley 2001 DMM	Regulated
Ono Sokki FFT Analyzer	Regulated
VGA Monitor	Regulated (Connected to PC-386)

Table 6. DSIS Cable Listing

Cable #	From	To	From Connector	To Connector	Type of Cable	Signal	Length (ft)
C1	Keithley 2001	prog. amp-J7	IEEE	IEEE	IEEE	amp commands	3
C2	prog sig cond-J10	main interface-IB1	BNC	BNC	RG-58U	displacement	2.5
C3	prog amp-J11	main interface-IB2	BNC	BNC	RG-58U	torque	2.5
C4	prog sig cond-J12	main interface-IB3	BNC	BNC	RG-58U	secondary	2.5
C5	AC cal sp-DISP1 out	signal access panel	BNC	chassis BNC	RG-58U	displacement	1.5
C6	AC cal sp-TORQ out	signal access panel	BNC	chassis BNC	RG-58U	torque	1.5
C7	AC cal sp-SEC out	signal access panel	BNC	chassis BNC	RG-58U	secondary	1.5
C8	AC cal sp-DISP1 out	DSP #1-1	BNC	mini XLR	RG-174	displacement	4
C9	AC cal sp-DISP2 out	DSP #2-2	BNC	mini XLR	RG-174	displacement	4
C10	AC cal sp-TORQ out	DSP #1-2	BNC	mini XLR	RG-174	torque	4
C11	AC cal sp-SEC out	DSP #2-1	BNC	mini XLR	RG-174	secondary	4
C12	Q-Flex-Fil Out	main interface-IB4	2 pin male A&N	4 pin female KPT-IB4	Belden 8762	Model attitude	2
C14	RPM indicator-J1	Tachometer board-J3	9 pin female DEM	9 pin male DEM	ribbon	rpm info	2
C15	g-meter out	signal access panel	BNC	chassis BNC	RG-58U	g-meter	8
C16	heater cntrlr +15v	junction panel-J9	BNC	GR plug	Belden 8719	power for g-meter	6
C17	RPM indicator-J3	SESB-J3	9 pin DBM	9 pin DBF	ribbon	encoder info	2
C18	junction panel-J1	prog sig cond-J0	12 pin female KPT	14 pin flat male	Belden 5486	displacement	6
C19	junction panel-J2	prog sig cond-J1	12 pin female KPT	14 pin flat male	Belden 5486	torque	6
C20	junction panel-J3	prog sig cond-J2	12 pin female KPT	14 pin flat male	Belden 5486	secondary	6
C21A	junction panel-J4	heater cntrlr-front	8 pin female KPT	5 pin male A&N	Bldn 8771	power	6
C21B	junction panel-J5	heater cntrlr-front	7 pin female A&N	5 pin male A&N	Bldn 8719	sensor	6
C22A	junction panel-J4	heater cntrlr-rear	8 pin femaleKPT	5 pin male A&N	Bldn 8771	power	6
C22B	junction panel-J5	heater cntrlr-rear	7 pin femaleA&N	5 pin male A&N	Bldn 8719	power & sensor	6
C23	junction panel-J7	Q-FLEX Chassis	6 pin female A&N	6 pin male A&N	2-Belden 8723	Model Attitude	4
C24	junction panel-J8	RPM indicator-J2	12 pin female KPT	12 pin male KPT	Alpha 5486	encoder	3
C25	junction panel-J10	mtr spd cntrlr-MC4	4pin female A&N	4 pin male A&N	Belden 8719	AOA motor control	3
C26	junction panel-J11	mtr spd cntrlr-MC3	3 pin female A&N	3 pin male A&N	Power cord	limit switches	2
C27	junction panel-J6	mtr spd cntrlr-MC1	7 pin female A&N	6 pin male A&N	B 8723&8719	MG set	2.5
C28	28V p.s.	mtr spd cntrlr-MC2	Screw Terminal	3 pin male A&N	Power cord	+/- 28V	4
C29	junction panel-J8	encoder	12 pin male KPT	10 pin female	Alpha 5486	encoder in & out	160 & 60
C30	main interface-IB14	DAS-20Board	50 pin microribbon	50 pin microribbon	ribbon	data code & AoA	5
C31	temp sensors	junction panel-J4	9 pin female Win	8 pin male KPT	Alpha 5483	temp sensors	160 & 60
C32	junction panel-J12	mtr spd cntrlr-MC6	2 pin female A&N	4 pin male KPT	Belden 8762	wind-on signal	3
C33	main interface-IB15	mtr spd cntrlr-MC5	6 pin female KPT	6 pin male KPT	Alpha 5483	amp & cal res sig	4
C34	PC-386 COM1	plotter-serial in	9 pin female DBM	25 pin male DBM	RS-232	plotter signals	7
C35	Signal access panel	Fluke 75	chasis BNC	BNC	RG-58U	Nulling	160
C36	SESB-J2	Tachometer board	9 pin DBF	9 pin DBM	6 conductor	encoder	1
C37	SESB-J1	HP 3325A sync out	mini XLR	BNC	RG-174	X8192	4
C38	IEEE-488 card	Keithley 2001	IEEE	IEEE	IEEE	DVM commands	3
C39	RPM indicator-J4	HP 3245A-TB1	BNC	BNC	RG-58U	1/REV NOT	3
C41	PC-386 LPT1	Laser Jet	parallel	parallel	printer cable	Laser Jet	3
C42	PC-386 COM2	mouse	9 pin DBF	Integral	ribbon	mouse	3
C43	prog sig cond-J0	HP 3245A-ch A out	14 pin flat male	BNC	Belden 8762	displacement sim	2
C44	prog sig cond-J1	HP 3245A-ch B out	14 pin flat male	BNC	Belden 8762	torque sim	2
C45	prog sig cond-J2	HP 3245A-ch B out	14 pin flat male	BNC	Belden 8762	secondary sim	2
C46	HP 3245A freq ref	HP 3325A ref out	BNC	BNC	RG-58U	function gen sync	3
C47	Signal access panel	HP 3325A sync out	BNC	BNC	RG-58U	X8192	3
C48	KSP-KP1	main interface-IB12	BNC	BNC	RG-58U	displacement	3
C49	KSP-KP3	main interface-IB9	BNC	BNC	RG-58U	torque	3
C50	KSP-KP2	main interface-IB7	BNC	BNC	RG-58U	secondary	3
C51	AC cal sp-HPB in	HP 3245A ch B out	BNC	BNC	RG-58U	AC Calibration	3
C52	AC cal sp-DP1 in	prog sig cond-J10	BNC	BNC	RG-58U	displacement 1	3
C53	AC cal sp-DP2 in	main interface-IB10	BNC	BNC	RG-58U	displacement 2	3
C54	AC cal sp-TORQ in	prog sig cond-J11	BNC	BNC	RG-58U	torque	3
C55	AC cal sp-SEC in	prog sig cond-J12	BNC	BNC	RG-58U	secondary	3
C56	AC cal sp-K in	KSP-KP0	BNC	BNC	RG-58U	Keithley select	3
C57	AC cal sp-K out	Keithley 2001-input	BNC	GR plug	RG-58U	encoder sim	3
C58	VGA Board	monitor	15 pin DBM	9 pin DBM	monitor cable	video	3
C59	AoA drive motor	junction panel-J10	4 pin female A&N	4 pin male A&N	#14 AWG	AoA motor drive	150
C60	AoA limit switches	junction panel-J11	3 pin male A&N	3 pin male A&N	Belden 8771	AoA limit switches	150
C61	Wind-on switch	junction panel-J12	2 pin male A&N	2 pin male A&N	Belden 8762	wind-on signal	150
C62	G-meter	junction panel-J9	4 pin male Win	4 pin male A&N	Belden 8761	G-meter	160
C63	Displacement bridge	junction panel-J3	9 pin female Win	12 pin male KPT	Belden 8761	Displacement	160

Table 6. Continued

C64	Torque bridge	junction panel-J2	9 pin female Win	12 pin male KPT	Belden 8761	Torque	160
C65	Secondary bridge	junction panel-J1	9 pin female Win	12 pin male KPT	Belden 8761	Secondary	160
C66	Heaters	junction panel-J5	4 pin female Win	7 pin male A&N	Belden 8719	Heater power	160
C67	Accelerometer	junction panel-J7	9 pin male Micro-D	6 pin female A&N	Belden 8723	Model attitude	160
C68	M-G Set	junction panel-J6	7 pin female A&N	7 pin male A&N	Belden 8771	Motor Control	150

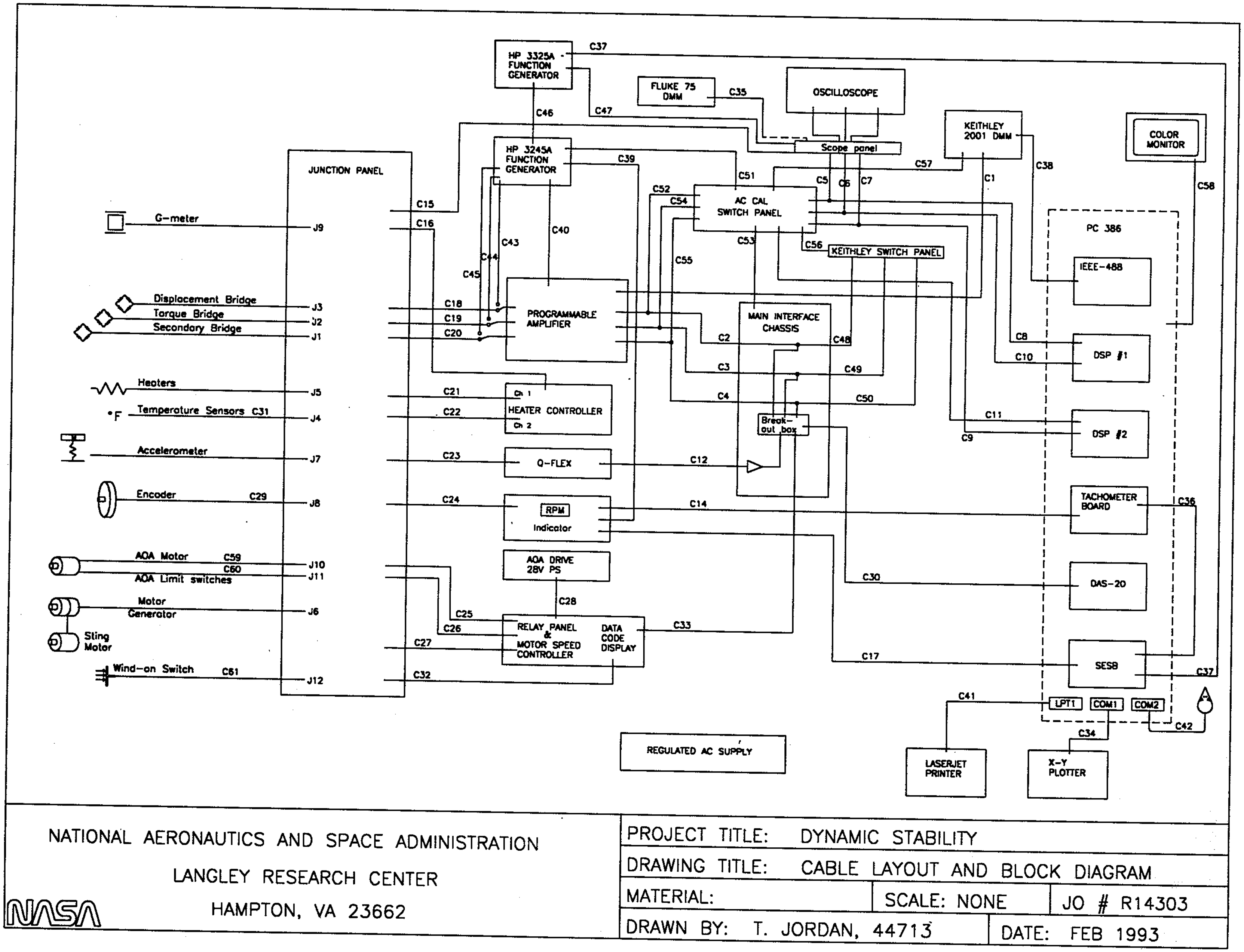


Figure 1. Cable Layout and Block Diagram

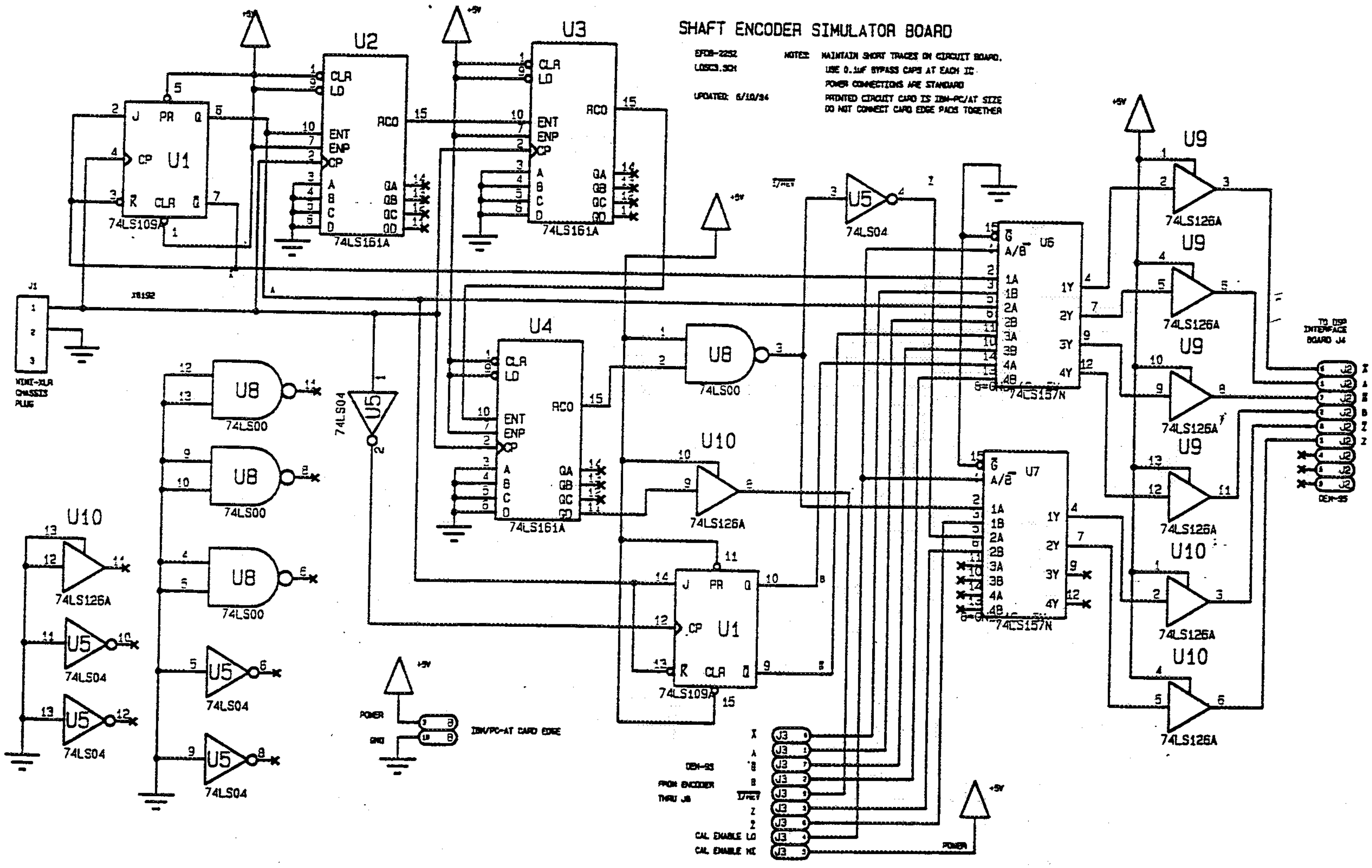


Figure 2. Shaft Encoder Simulator Board

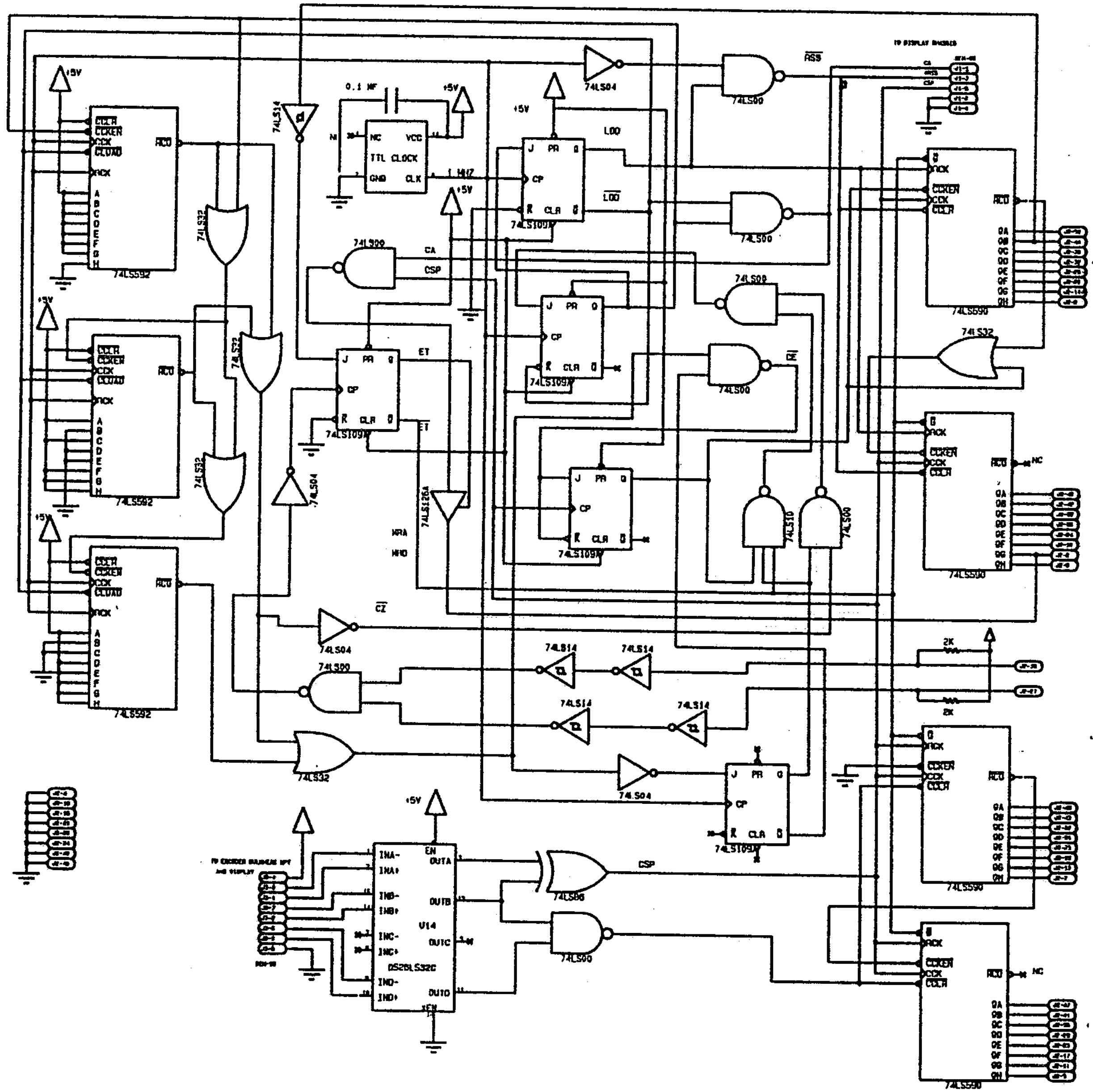
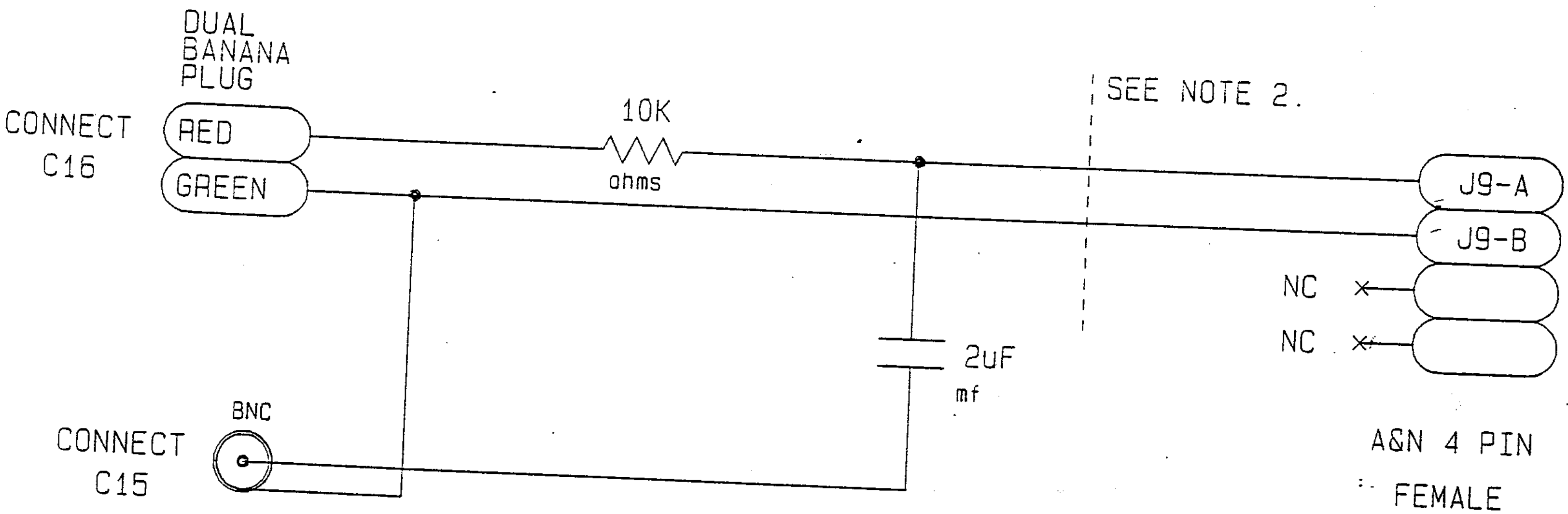


Figure 3. Tachometer Board

G-METER OUTPUT



NOTES:
1. MINI-BOX MOUNTED INSIDE CHASSIS NEXT TO JUNCTION BOX
2. USE 1/4" GROMMET THRU MINI-BOX FOR THESE CONDUCTORS
3. PCAD 6.00 FILE GMETER.SCH, DATE 2/24/93

Figure 4. G-meter Output Circuit

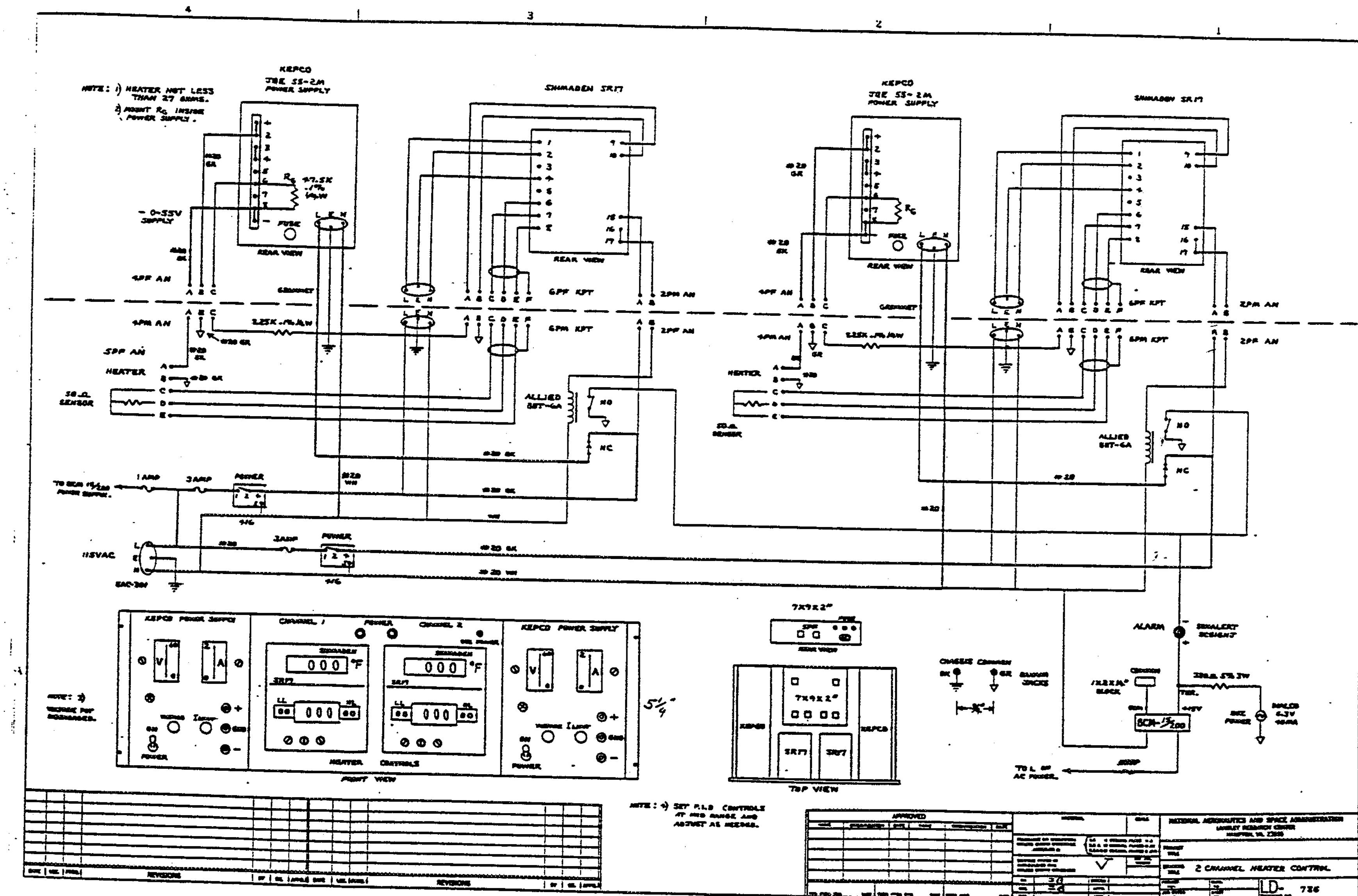


Figure 5. Heater Controller

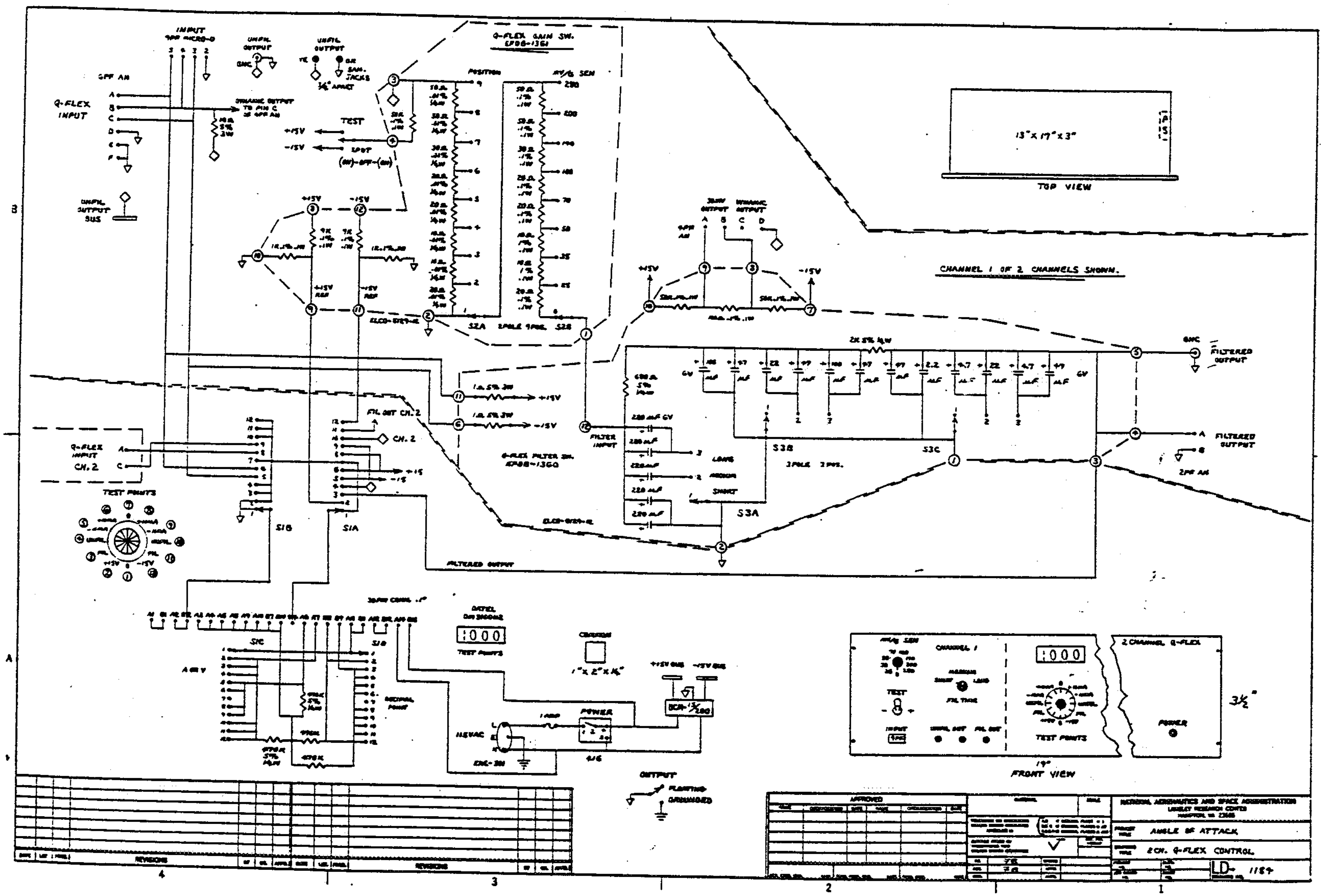


Figure 6. Q-Flex Chassis

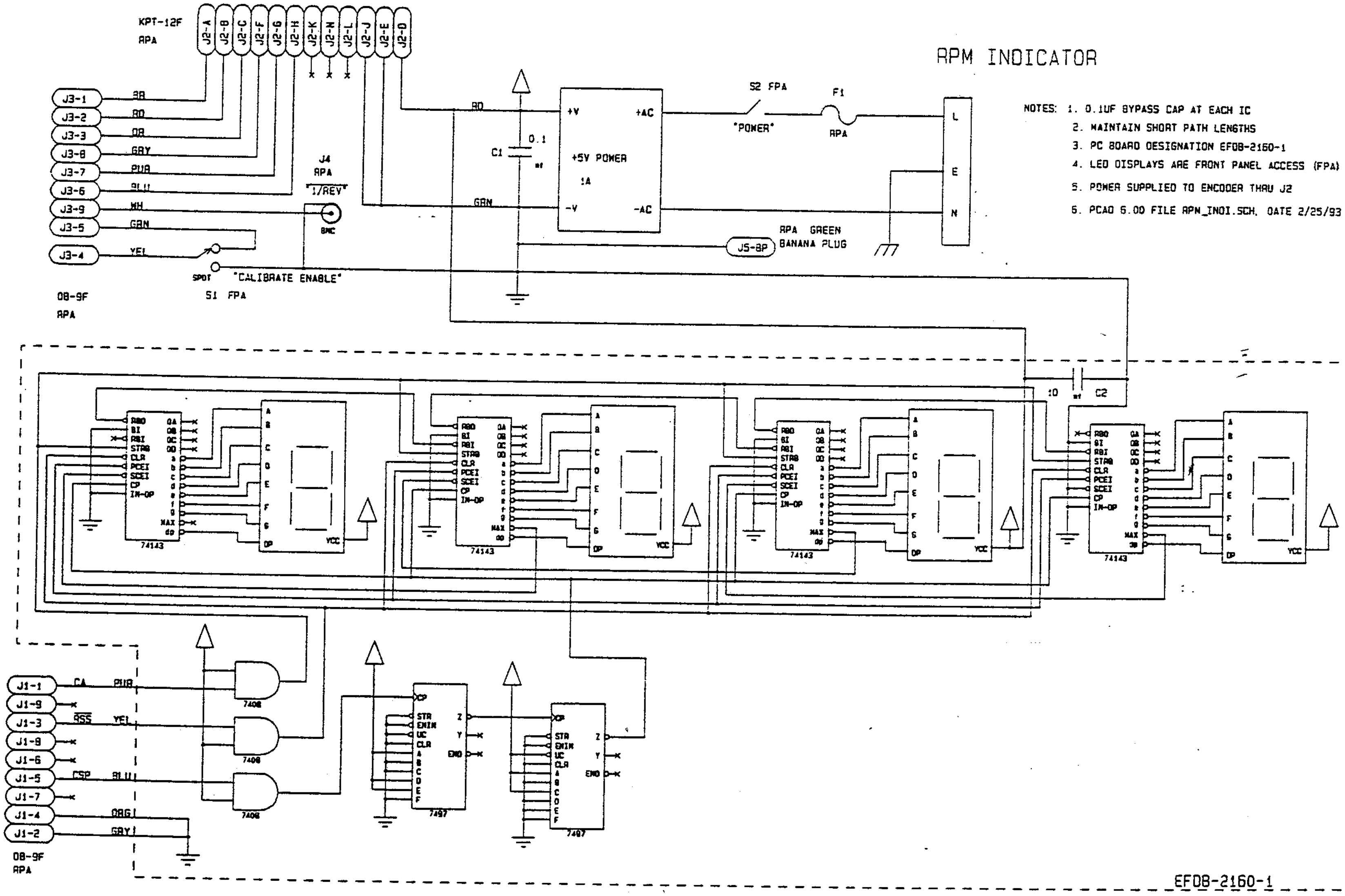


Figure 7. RPM Indicator Chassis

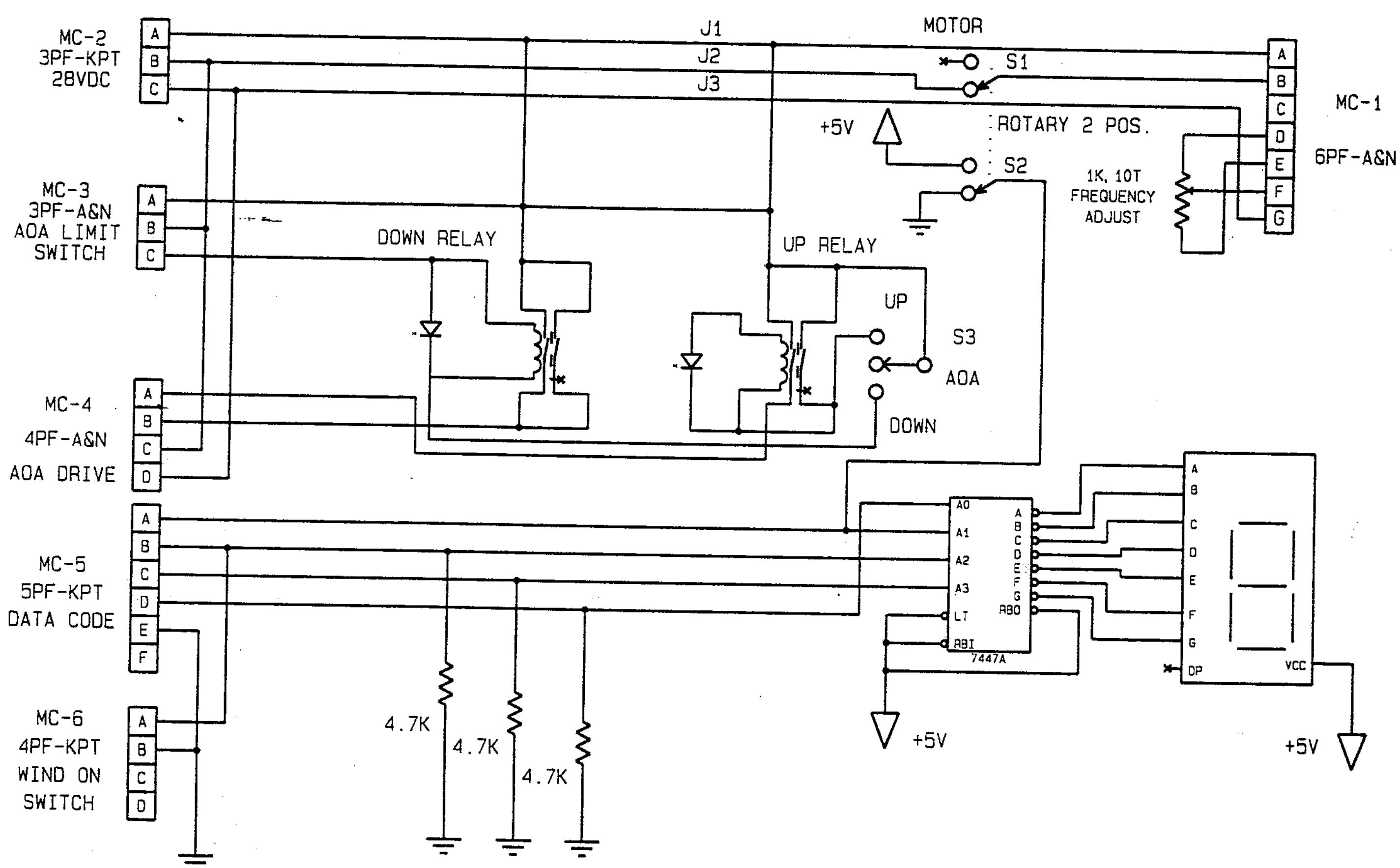


Figure 8. Motor Speed Controller and Data Code Display

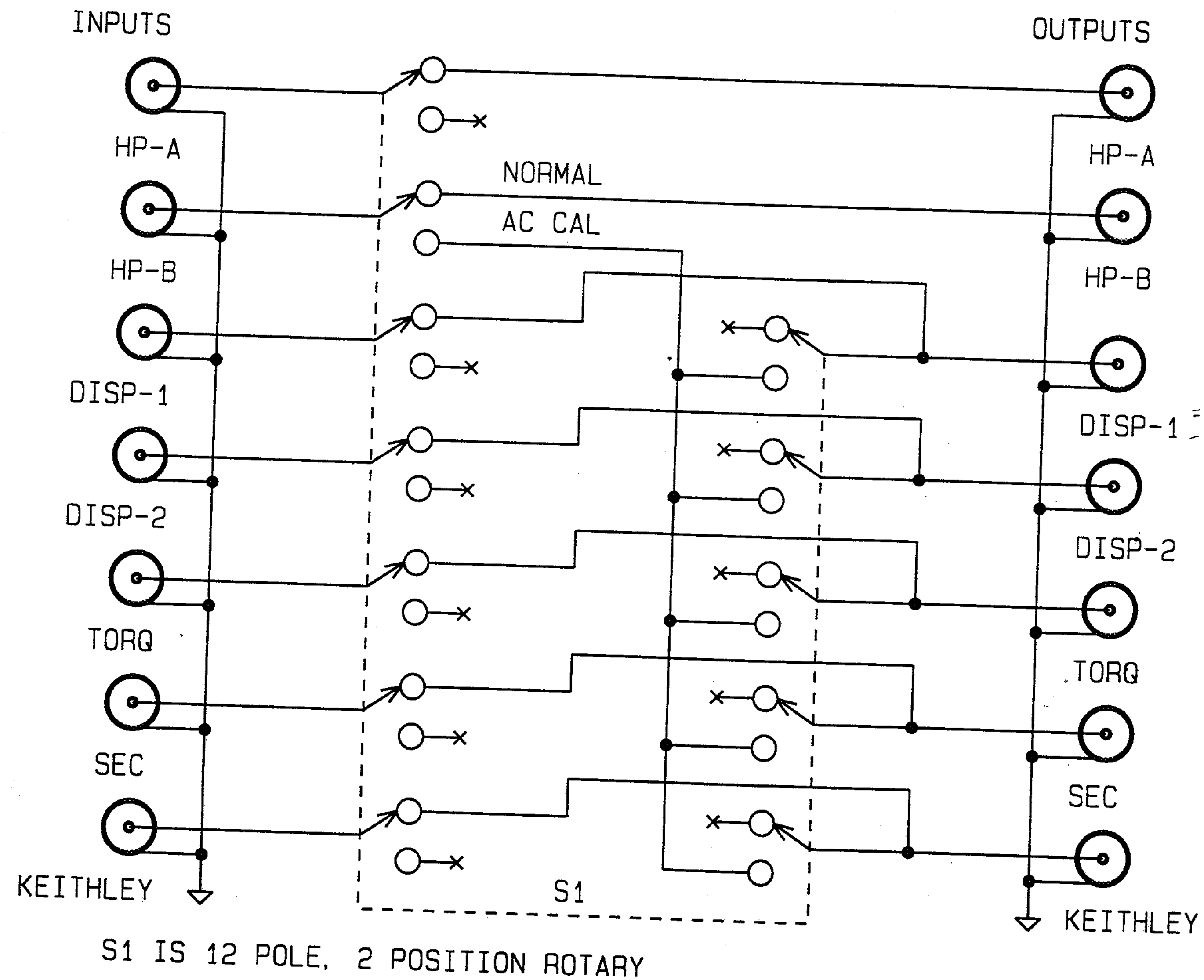


Figure 9. AC CAL Switch Panel

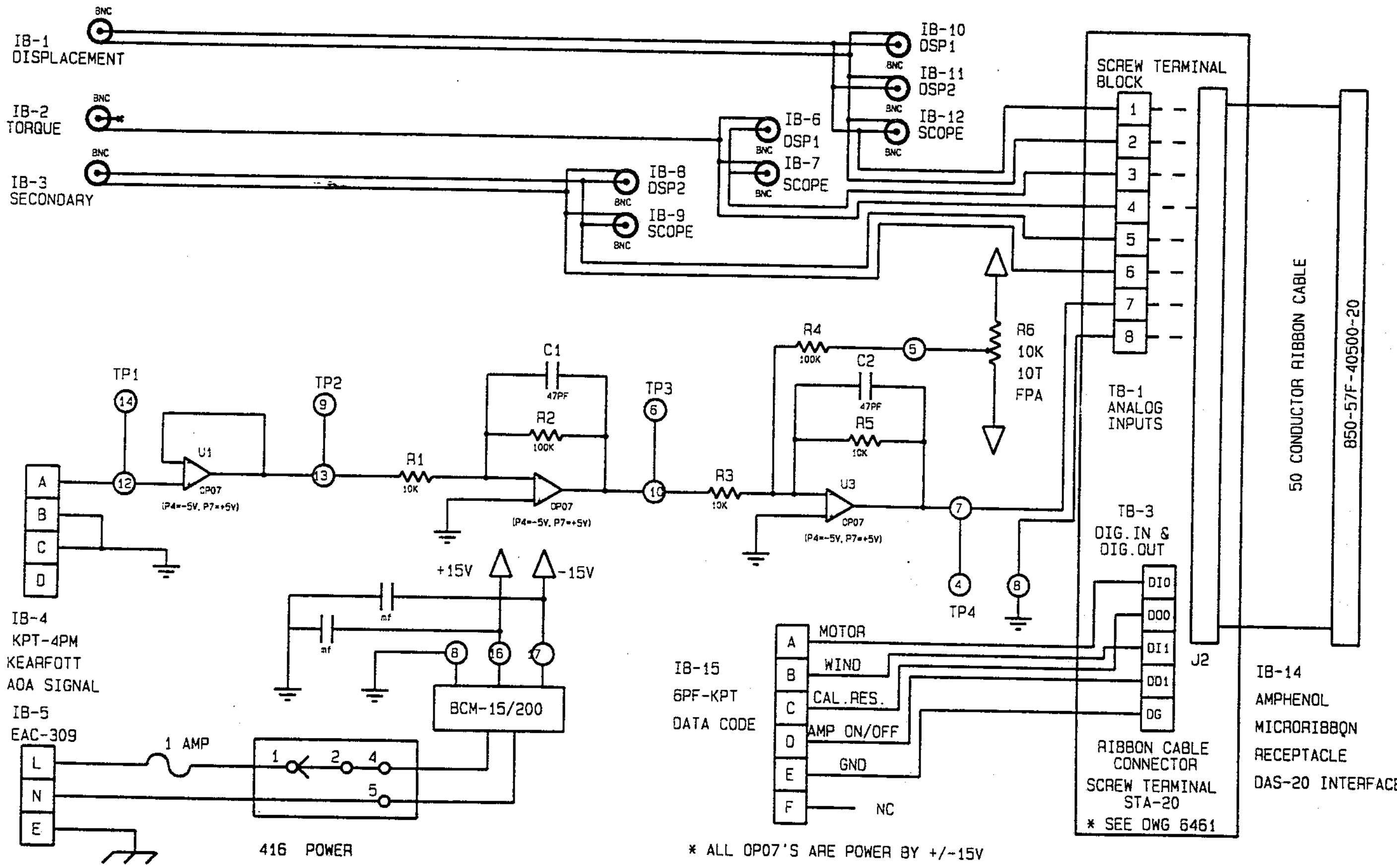


Figure 10. Main Interface Chassis

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This paper is a hardware description manual for the Dynamic Stability Instrumentation System that is used in specific NASA Langley wind tunnels. The instrumentation system performs either a synchronous demodulation or a Fast Fourier Transform on dynamic balance strain gage signals, and ultimately computes aerodynamic coefficients. The DSIS consists of a double rack of instruments, a remote motor-generator set, two specical stings each with motor driven shafts, and specially designed balances. The major components in the instrumentation rack include a personal computer, digital signal processor microcomputers, computer-controlled signal conditioners, function generator, digital multimeter, and an optional Fast Fourier Transfor Analyzer.

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