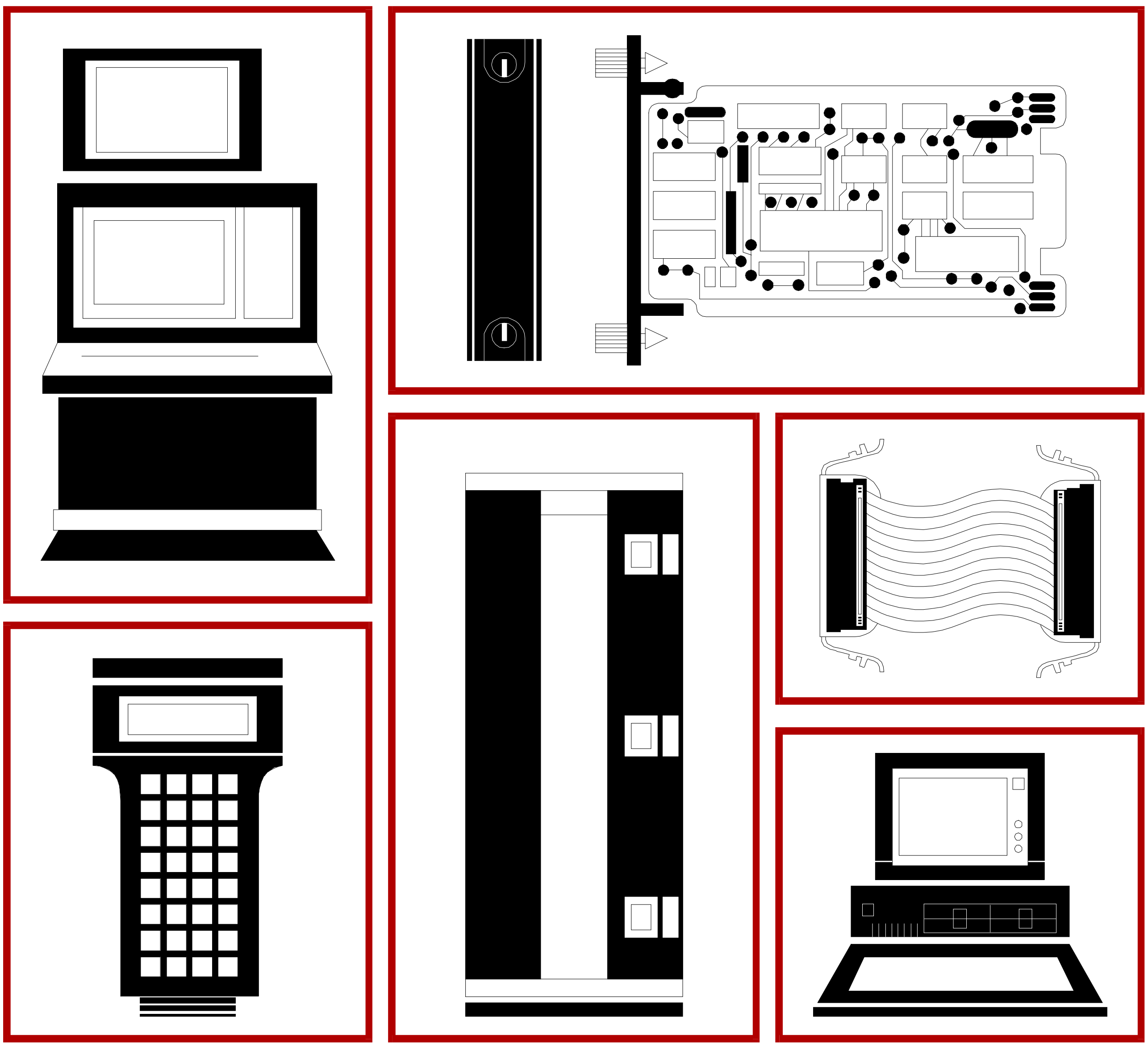
E96-315

Bailey infi 90

Instruction

Hydraulic Servo Slave Module

(IMHSS02)



Bailey

Process Control and
Automation Solutions
from Elsag Bailey Group

WARNING notices as used in this instruction apply to hazards or unsafe practices that could result in personal injury or death.

CAUTION notices apply to hazards or unsafe practices that could result in property damage.

NOTES highlight procedures and contain information that assists the operator in understanding the information contained in this instruction.

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Preface

The Hydraulic Servo Slave Module (IMHSS02) is a position control module. It interfaces a servo valve to the Multi-Function Processor (IMMFP01/02/03) or Multi-Function Controller (IMMFC03/04/05). The MFP or MFC controls the position of a steam or gas turbine throttle valve by sending a position demand to the HSS. The HSS drives its outputs to open or close the throttle valve to match the position demand. The MFP or MFC uses the Frequency Counter Slave (IMFCS01) to measure the turbine speed. The FCS measures turbine speed by counting and timing pulses from a magnetic pickup on the turbine shaft. The controller or processor module uses this count to calculate turbine speed and calculate a new demand based on a setpoint.

The IMHSS02 is a compatible replacement of the IMHSS01. This manual provides the user with information and instructions for installation, operation and troubleshooting of the HSS. Anyone involved with the installation and operation of the hydraulic servo slave should carefully read and understand this manual.

General information about the module and related equipment is contained herein. This manual is not an application guide.

List of Effective Pages

Total number of pages in this manual is 61, consisting of the following:

Page No.	Change Date
Preface	Original
List of Effective Pages	Original
iii through vii	Original
1-1 through 1-7	Original
2-1 through 2-9	Original
3-1 through 3-8	Original
4-1 through 4-6	Original
5-1 through 5-3	Original
6-1 through 6-9	Original
7-1 through 7-1	Original
8-1 through 8-1	Original
A-1 through A-2	Original
B-1 through B-3	Original
C-1 through C-2	Original
Index-1 through Index-3	Original

NOTE: On an updated page, the changed text or table is indicated by a vertical bar in the outer margin of the page at the changed area. A changed figure is indicated by a vertical bar in the outer margin next to the figure caption. The date the update was prepared will appear beside the page number.

Safety Summary

GENERAL WARNINGS	**Equipment Environment** All components whether in transportation, operation, or storage must be in a noncorrosive environment. **Electrical Shock Hazard During Maintenance** Disconnect power or take precautions to ensure that contact with energized parts is avoided when servicing. **Special Handling** This module uses Electrostatic Sensitive Devices (ESD).

SPECIFIC CAUTIONS	Only qualified personnel should install the throttle valve, hydraulic actuator, servo valve and linear variable differential transformer. Improper installation can cause damage to plant equipment, reduce plant performance and compromise the safety of plant personnel (p.3-2). Only qualified personnel should configure these switches. Damage or misoperation could occur if switches are improperly configured (p.3-3).

Sommaire de Sécurité

AVERTISSEMENTS D’ORDRE GÉNÉRAL	**Environment de l'equipment** Ne pas soumettre les composants a une atmosphere corrosive lors du transport, de l'entreposage ou de l'utilisation. **Risques de chocs electriques lor de l'entretien** S'assurer de debrancher l'alimentaion ou de prendre les precautions necessaires a eviter tout conatact avec des composants sours tension lors de l'entretien. **Precautions de Manutention** Ce module contient des composantes sensibles aux decharges electro-statiques.

ATTENTIONS D’ORDRE SPÉCIFIQUE	Seul le personnel qualifie doit installer la soupape modulatrice, l'actioneur hydraulique, la soupape de pilotage et le transformateur lineaire a differentiel variable. Une installation inadequate pourrait endommager l'equipment en chantier, reduire les performances de l'usine et mettre en jeu la securite du personnel (p.3-2). La configuration de ces interrupteurs ne devait etre effectuee qlue par un personnel qualifie. Des dommages ou une mauvaise operation pourraient resulter d'une mauvaise configuration des interrupteurs (p. 3-3).

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SECTION 1 - INTRODUCTION

INTRODUCTION

The Hydraulic Servo Slave (IMHSS02) is a position control module. It provides an interface through which a controller or processor module can control a hydraulic actuator via a servo valve. By regulating the current to the servo valve, it initiates a change in actuator position. A linear variable differential transformer (LVDT) provides actuator position feedback to the HSS. Typical uses for the HSS are positioning of steam turbine throttle and control valves, gas turbine fuel valves, inlet guide vanes and nozzle angle.

INTENDED USER

Anyone who installs, operates and maintains the HSS should read and understand this manual before placing it into service. Installation requires a technician or engineer with analog control tuning experience. Operation requires an individual who knows turbine start-up and plant operating procedures.

HARDWARE DESCRIPTION

The HSS is an intelligent module, with on-board microprocessor, memory and communication circuitry. The module consists of a printed circuit card attached to a faceplate. Two status LEDs are visible through the faceplate. The HSS occupies one slot in a module mounting unit (MMU).

HARDWARE APPLICATION

The HSS module interfaces a controller or processor module to a servo valve, providing control (manual or automatic) of a hydraulic actuator. The hydraulic actuator positions a gas turbine fuel valve or steam governor valve. As the fuel or steam valve opens or closes, it regulates fuel or steam flow to the turbine thus controlling the turbine speed. Figure 1-1 shows an example of the HSS within the INFI 90® hierarchy.

In most applications, the HSS works with the frequency counter slave (FCS) through a multi-function processor (MFP). The FCS counts and times pulse inputs from a magnetic sensing device on the turbine shaft. The MFP uses the data from the FCS to calculate turbine speed. The configuration within the MFP uses the calculated speed to drive the servo valve outputs according to the control strategy of the user.

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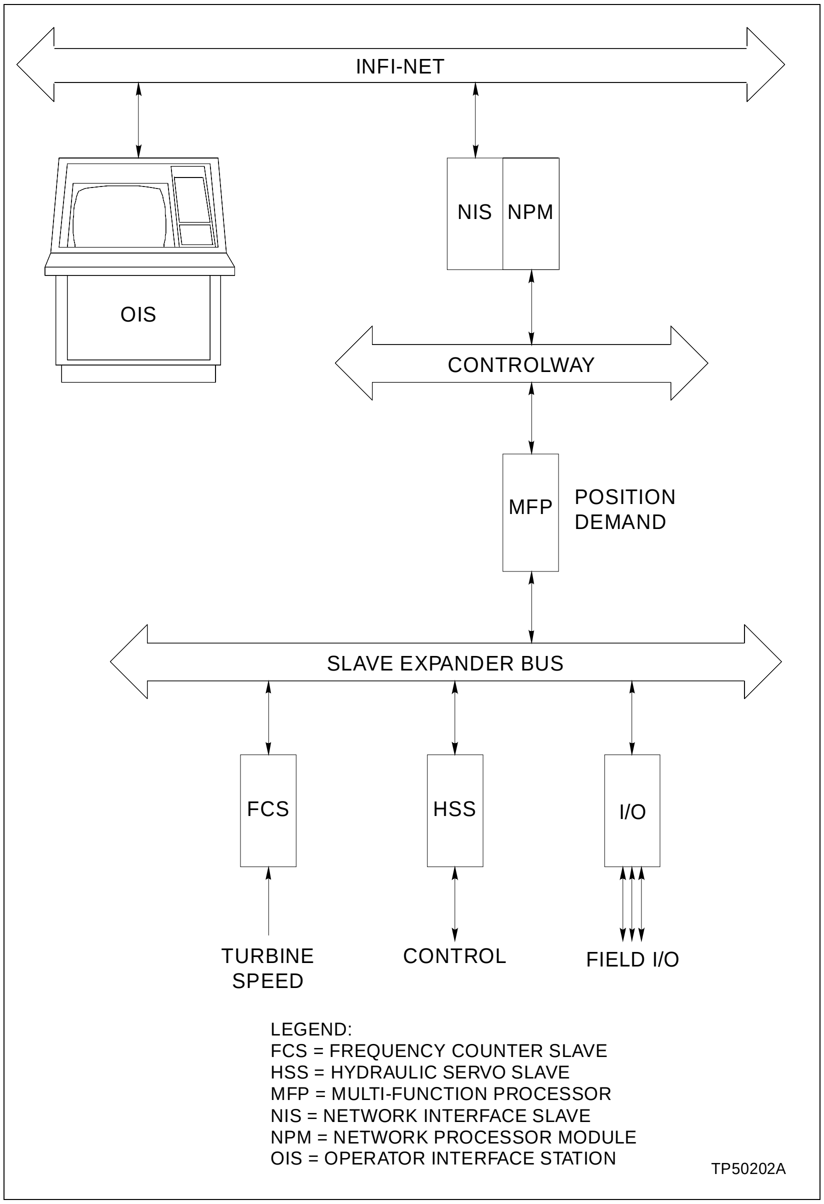

Figure 1-1. The HSS within the INFI 90 Hierarchy

INSTRUCTION CONTENT

This manual is divided into eight sections. Read this document before installing or operating the HSS. A summary of section content follows:

Introduction Introduction contains general information and technical specifications.

Description and Operation This section uses block diagrams, schematics and text to explain module operation.

Installation Installation covers the preliminary steps to prepare the module for operation. It covers switch settings, configuration and field wiring.

Calibration The calibration section explains how to calibrate the module with the LVDT and tune the control loop before placing it into operation.

Operating Procedures The operation section provides information on daily use, start-up procedures and normal operation.

Troubleshooting This section explains LED conditions, lists status messages and shows corrective action when problems occur.

Maintenance The maintenance section contains a table of scheduled maintenance procedures.

Support Services This section explains the services and training that Bailey Controls makes available to their customers.

Appendices There are three appendices that provide a quick reference of HSS module edge connector pin assignments, and explain how to configure the NTDI01 Termination Unit and NIDI01 Termination Module.

HOW TO USE

Read this manual before handling the HSS. Refer to a specific section for information as needed.

1. Read Section 5 before installing the HSS.

2. Read and do the steps in Section 3.

3. Read and do the steps in Section 4.

4. Refer to Section 6 for what to do if a problem occurs.

5. Refer to Section 7 for scheduled maintenance requirements.

6. Use Section 8 for a replacement parts list and warranty information.

7. Refer to the appendices for a quick reference of termination unit or module installation information.

NOMENCLATURE

Hardware	Nomenclature
IEMMU01/02/04	Module Mounting Unit
IMFCS01	Frequency Counter Slave Module
IMMFP01/02/03 IMMFC03/04/05	Multi-Function Processor Module Multi-Function Controller Module
NIDI01 NTDI01	Digital Input Termination Module Digital Input Termination Unit
NKTM01, NKTU02/12 NKTU01/12	Termination Cable, NIDI01 to IMHSS02 Termination Cable, NTDI01 to IMHSS02

GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Definition
ADC	Analog-to-Digital Converter.
A/D Conversion	Analog-to-Digital Conversion. Process of generating a digital representation of the magnitude of an analog signal.
Controlway	A high speed, redundant, peer-to-peer communication link. Used to transfer information between intelligent modules within a process control unit.
CTM	Configuration and Tuning Module. Provides a local means for system configuration, tuning and monitoring of intelligent masters over module bus.
CTT	Configuration and Tuning Terminal. A handheld module with the same functionally as the configuration and tuning module.
DAC	Digital-to-Analog Converter.
D/A Conversion	Digital-to-Analog Conversion. Process of generating an analog signal of a magnitude that corresponds to a digital value.
Dipshunt	A dual in-line package with shorting bars.
Dipswitch	A dual in-line package that contains switches.
ESD	Electrostatic Sensitive Devices. Electronic components subject to damage or failure when exposed to an electrostatic charge; require special handling.
FCS	Frequency Counter Slave.
FTP	Field Termination Panel. A panel inside the INFI 90 cabinet that provides a place to mount termination units.

GLOSSARY OF TERMS AND ABBREVIATIONS *(continued)*

Term	Definition
Function Code	An algorithm which manipulates specific functions. These functions are linked together to form the control strategy.
Hydraulic Actuator	A cylinder that converts hydraulic power into mechanical work (opening or closing a valve).
LVDT	Linear Variable Differential Transformer. A transformer that provides actuator position feedback by inducing a differential voltage proportional to the core position (hydraulic actuator position), when driven by an excitation voltage.
MCU	Microcontroller. A self-contained microprocessor with on-board memory, I/O ports and support circuitry.
MFC	Multi-Function Controller Module. A multiple loop controller with data acquisition and information processing capabilities.
MFP	Multi-Function Processor Module. A multiple loop controller with data acquisition and information processing capabilities.
Module Bus	Peer-to-peer communication link used to transfer information between intelligent modules within a process control unit.
MMU	Module Mounting Unit. A card cage that provides electrical and communication support for INFI 90/Network 90® modules.
OIS	Operator Interface Station. Integrated operator console with data acquisition and reporting capabilities. It provides a digital access into the process for flexible control and monitoring.
Servo Valve, Hydraulic	A valve, driven by a calibrated electrical signal, that loads or unloads hydraulic fluid to one side of a double acting hydraulic actuator.
Slave Expander Bus	Parallel communication bus between the master and slave modules.
TMU	Termination Mounting Unit. A card cage that provides housing for termination modules and cables.
TM	Termination Module. Provides input/output connection between plant equipment and the INFI 90/Network 90 modules.
TU	Termination Unit. Provides input/output connection between plant equipment and the INFI 90/Network 90 modules.

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REFERENCE DOCUMENTS

Number	Document
I-E92-501-2	Configuration/Tuning Terminal (CTT02)
I-E93-903	Configuration/Tuning Module (NCTM01)
I-E96-100	Operator Interface Station (IIOIS20) Operation/Configuration
I-E96-200	Function Code Application Manual
I-E96-201	Multi-Function Processor Module (IMMFP01)
I-E96-202	Multi-Function Processor Module (IMMFP02)
I-E96-203	Multi-Function Processor Module (IMMFP03)
I-E96-211	Multi-Function Controller Module (IMMFC03)
I-E96-212	Multi-Function Controller Module (IMMFC04)
I-E96-213	Multi-Function Controller Module (IMMFC05)
I-E96-314	Frequency Counter Slave Module (IMFCS01)
I-E96-410	Digital Input Termination Module (NIDI01)
I-E96-424	Digital Input Termination Unit (NTDI01)
TP89-2	Analog Control Techniques and Tuning

SPECIFICATIONS

GENERAL	
Microprocessor	8 bit processor running at 4 MHz
Process I/O	2 analog inputs - LVDT secondary inputs 1 and 2. 3 analog outputs - servo drive outputs 1 and 2, LVDT primary drive.
Digital I/O	3 inputs - raise, lower, trip bias 1 output - emergency manual
System Communication	8 bit parallel through the slave expander bus.
POWER REQUIREMENTS	
Operating	+5 VDC @ 160 mA typical +15 VDC @ 70 mA typical -15 VDC @ 60 mA typical +24 VDC @ 15 mA typical
Consumption	5 VDC - 0.80 watts +15 VDC - 1.05 watts -15 VDC - 0.90 watts +24 VDC - 0.36 watts
Surge Protection	Meets IEEE-472-1974 Surge Withstand Capability Test.

SPECIFICATIONS *(continued)*

OPERATING	
LVDT Supply Primary Excitation Output	1 kHz, 2.5 kHz or 10 kHz (selectable), 4 to 12 volts peak-to-peak adjustable in steps. Minimum LVDT primary impedance 500 ohms.
LVDT Secondary Two Position Inputs	30 volts peak-to-peak, ±10 VDC common mode, 20k ohms (differential input) impedance
Output to Servo Valve Coils	Two redundant analog outputs at ±0.024 amps each. Minimum coil impedance 80 ohms each.
Servo Output Protection	Current limiting resistor allows shorting or opening one output without impairing control from the other output.
Digital Output	Independent, optically isolated, open collector outputs. On: V_{out} = 2.4 VDC maximum I_{out} = 250 mA maximum Off: V_{out} = 24 VDC nominal I_{out} = 10 uA maximum
Digital Inputs	Three, optically isolated, contact inputs. On: V_{in} = 10 VDC minimum I_{in} = 4.5 mA forward current typical at V_{in} = 24 VDC Off: V_{in} = 2 VDC maximum turn-off voltage I_{in} = 10 uA maximum leakage current
ENVIRONMENTAL	
Electromagnetic/Radio Frequency Interference	Values are not available at this time. Keep cabinet doors closed. Do not use communication equipment any closer than two meters from the cabinet.
Ambient Temperature	0° to 70°C (32° to 158°F)
Atmospheric Pressure	Sea level to 3 km (1.86 miles)
Humidity	5% to 90% RH (±5%) up to 55°C (noncondensing) 5% to 40% RH (+5%) at 70°C (noncondensing)
Air Quality	Noncorrosive
MOUNTING	The HSS occupies one slot in the INFI 90 module mounting unit (MMU).
CERTIFICATION	CSA certified for use as process control equipment in an ordinary (nonhazardous) location.

Specifications subject to change without notice.

SECTION 2 - DESCRIPTION AND OPERATION

INTRODUCTION

This section explains the operation of the hydraulic servo slave (HSS). It gives an overview of the slave and related modules within a process control system and explains the operation of key module circuitry.

CONTROL LOOP OPERATION

The hydraulic servo slave, frequency counter slave (FCS) and multi-function processor (MFP) form the controlling segment of a closed loop control system. The MFP is the master module and directs the control process. The HSS and FCS are slave modules that interface the process to the MFP. Figure 2-1 shows a diagram of the turbine speed control loop and the control signals to and from the process.

Hydraulic Servo Slave

The HSS provides control of throttle valve position in a turbine speed control system. The MFP sends data to the hydraulic servo slave, which directs the control of a hydraulic actuator (via a servo valve). By sending a position demand to the HSS, the MFP initiates a change in turbine speed. The position demand travels over the slave expander bus to the HSS. An on-board microcontroller reads the demand and loads it into a digital-to-analog converter (DAC). The resulting analog value drives the servo valve. The servo valve loads hydraulic fluid to one side of a double acting hydraulic actuator. As the hydraulic actuator opens or closes the throttle valve, the turbine speed changes.

For the MFP to work with the HSS, it requires function code 150 in its configuration. Function code 150 defines the slave address, mode of operation (calibration or normal), calibration cycle time and stores calibration data. The twelve output blocks include actuator position, LVDT null position and status outputs for the module and process equipment.

A linear variable differential transformer measures actuator position. The HSS supplies either a 1000, 2500 or 10,000 hertz excitation voltage (switch selectable) to the primary side of the LVDT. The secondary of the LVDT develops a differential voltage proportional to the position of the hydraulic actuator. The HSS converts the differential voltage to digital data and sends it to the MFP. Using the data the MFP stores (during valve calibration) in its configuration specifications (S8-S9), it translates the LVDT secondary differential voltage into actuator position

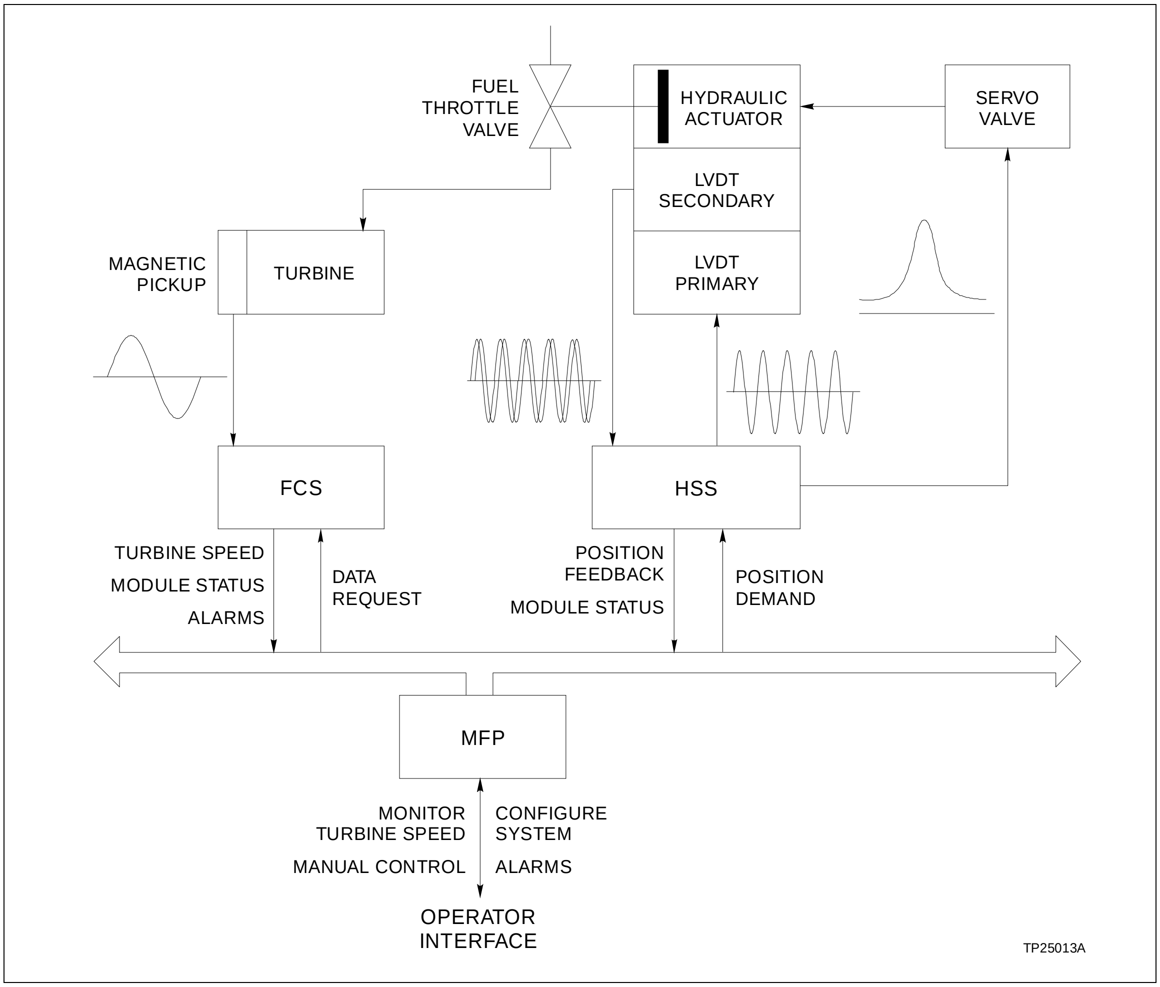


Figure 2-1. Turbine Speed Control Loop

feedback. The HSS is self checking and notifies the MFP if a failure occurs.

The operator can initiate manual control of the turbine throttle valve if a HSS communication failure with the MFP occurs. The HSS provides inputs that the user hard wires to a +24 VDC source. The user directs the HSS to raise or lower the actuator through external inputs (pushbuttons, contacts, etc.). Also, a trip bias circuit on the HSS drives the fuel throttle valve to the closed position in an emergency.

Frequency Counter Slave

The FCS detects turbine speed by counting pulses it receives from a magnetic pickup on the turbine shaft. Additionally, it keeps a 24 bit timer value corresponding to the period of the pulse count. It stores these values in a buffer and sets a data available status bit to notify the MFP that it has current data. FCS operation is automatic. It continuously updates the count and holds it for the MFP.

For the MFP to work with the FCS, it requires function code 145 in its configuration. Function code 145 defines the slave address, high/low speed alarms and high/low rate of change alarms. The block output is frequency of input pulses in hertz. The frequency counter slave continuously checks itself and notifies the MFP if a failure occurs.

Multi-Function Processor

The MFP is the master module of the control loop and controls turbine speed according to the users control strategy. The MFP requests data from the FCS to calculate turbine speed. If the FCS has data available, it sends it to the MFP. If there is no data available the MFP must make another request. If the turbine speed goes above or below the speed set point in the MFP configuration, the MFP will send a position demand to the HSS to adjust the throttle valve. This process repeats continuously at the cycle time of the MFP.

The user sets the turbine speed limits and high/low speed alarms during configuration of the MFP and slave modules. Additionally, the user calibrates the hydraulic actuator and LVDT. The MFP sends data, module status and alarms to the operator interface during normal operation. The operator can monitor system operation and initiate automatic or manual control through the operator interface.

HSS MODULE OPERATION

The HSS interfaces the MFP to a servo valve, providing the MFP with position control of a fuel throttle valve or steam governor valve. The HSS microcontroller carries the workload. It is able to perform multiple tasks with the help of the module support circuitry. The microcontroller provides the intelligence (firmware) needed to relay position demands from the MFP, read position feedback information, set targets for the output, present module status information to the MFP, direct manual control and do self check diagnostics. There are seven functional blocks (see Figure 2-2).

Slave Expander Bus Interface (XBUS I/O)
Status and Data Buffers
Microcontroller (MCU)
Position Demand and Output
Position Feedback Input
LVDT Oscillator
Digital I/O

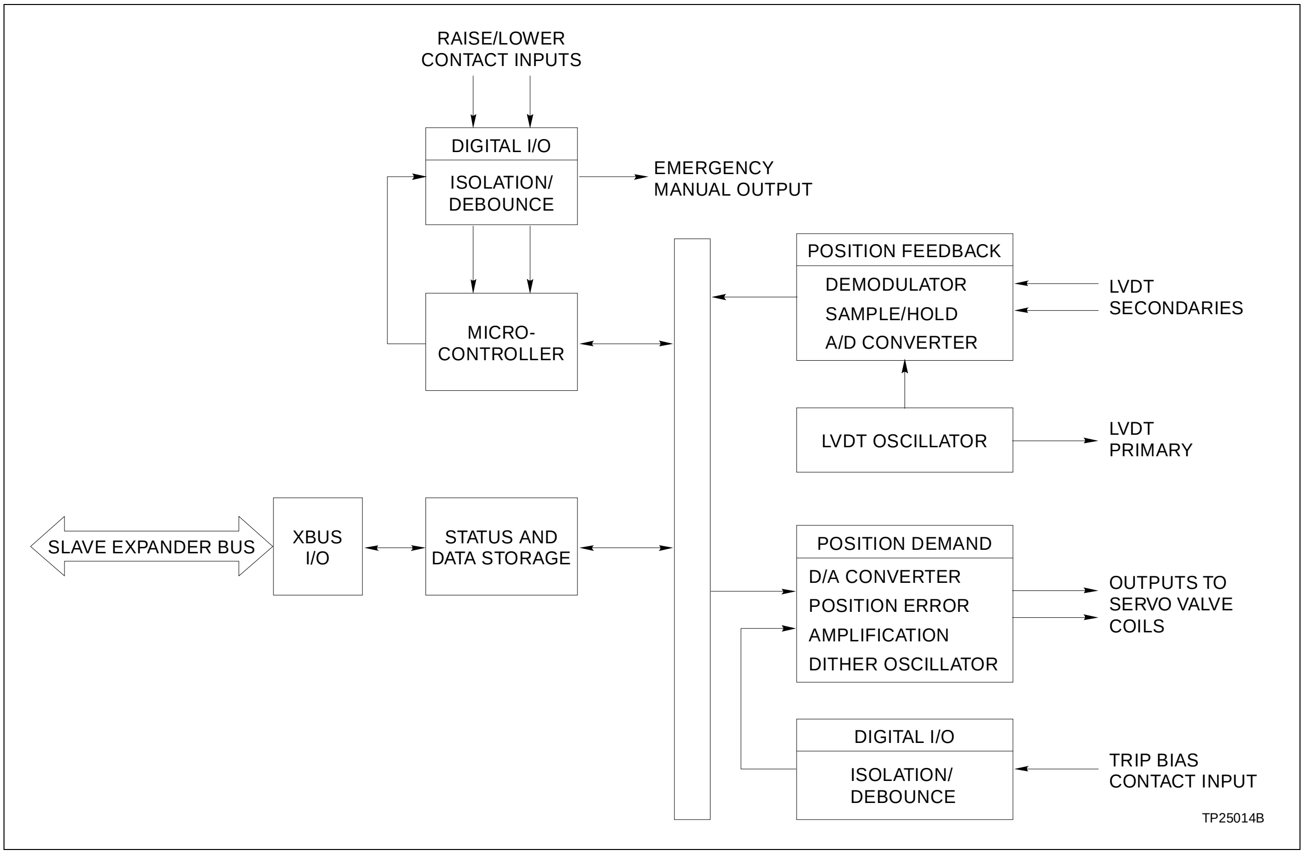


Figure 2-2. HSS Functional Block Diagram

All the blocks of the support circuitry help the MCU direct module activity and interface the control loop. Power enters the board by way of the module mounting unit backplane. The slave expander bus interface provides slave communication with the processor module. The position demand circuitry performs digital-to-analog conversion of position demands, while the output circuitry amplifies the current driving the servo valve coils. A dither oscillator prevents fuel valves from freezing in one position. The position feedback block demodulates feedback from the LVDT secondary and converts it from an analog signal to digital data. A frequency selectable (1, 2.5 or 10 kilohertz) oscillator supplies the excitation voltage for the LVDT primary. The digital I/O circuitry provides isolated DC inputs that allows the operator to control the actuator position when a module communication failure interrupts automatic control.

HSS MODULE CIRCUITRY

The following text explains the operation of the seven functional blocks that make up the hydraulic servo slave module.

SLAVE EXPANDER BUS INTERFACE

The slave expander bus interface enables communication between the processor module and the HSS. This communication channel is a an eight bit parallel data bus with two control lines. A Bailey Controls designed integrated circuit performs the communications protocol for interfacing the data and status information to the processor module. It performs address compare, R/W strobe generation and contains bus drivers and receivers.

The user selects the slave expander bus address by setting a dipswitch on the HSS. The address byte precedes every data transfer. The slave expander bus integrated circuit does an address comparison before allowing data to transfer on the slave expander bus. If the addresses match, the MFP can strobe data to or from the slave expander bus.

The MFP sends the following information and commands to the HSS by way of the slave expander bus interface:

Position demand
Calibrate/operate mode select
Calibrate go/hold status
Calibration stroke time
Number of calibration cycles
Null check request

The HSS sends the following information and status to the MFP by way of the slave expander bus interface:

Actuator position
Actuator at LVDT null
New calibration data
Slave, mode = normal/emergency manual
Calibration status
Good/bad status for:
- Positioning
- A/D and D/A
- Oscillator
- LVDT secondaries
- Output 1
- Output 2
- Microprocessor/hardware
- Communications

STATUS AND DATA BUFFERS

The status and data buffers hold status information and process data traveling between the microcontroller and the slave expander bus I/O. This allows the two asynchronous busses to operate together and exchange information using handshake signals.

MICROCONTROLLER

The HSS uses an eight bit microprocessor to control board functions and communicate with the MFP through the slave expander bus interface. The microcontroller controls the analog-to-digital processing, passes position feedback and status information to the MFP, reads control data from the MFP, writes position demands to the digital-to-analog converter and does self checks.

The microcontroller also controls the emergency manual circuit. This circuit provides isolated contacts the user connects to +24 VDC, giving the operator a way to initiate control of the hydraulic actuator in the event the MFP communications are lost. By activating the raise or lower contacts the operator tells the MCU to change the actuator position. The microcontroller also writes to a digital output to tell the operator the module is in the emergency manual mode of operation.

POSITION DEMAND AND OUTPUT

There are four parts to the position demand and output block, the digital-to-analog converter, position error, servo amplifier and dither oscillator. The output circuit provides proportional plus integral plus derivative (PID) closed loop control on the entire servo valve system. Figure 2-3 shows a simplified diagram of the position demand and output circuit.

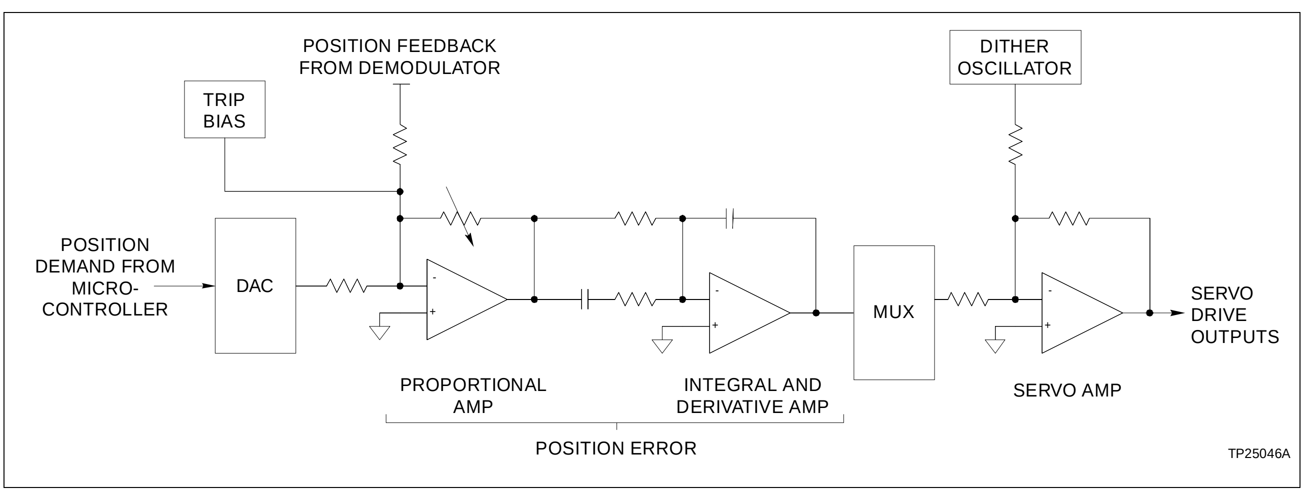


Figure 2-3. Position Demand and Output Circuit

Digital-to-Analog Converter

The DAC receives the position demand from the microcontroller. It converts the data from a digital word to an equivalent analog signal. The DAC outputs the analog position demand to the position error circuit.

Position Error

The position error circuit compares position demand with position feedback. The output of this circuit is the difference between the position feedback and the position demand signal. This signal goes to the servo amplifier. The position error output is zero when position demand and position feedback are equal. When the amplifier output is zero, indicating that the actuator is in the correct position, the servo amplifier holds the servo valve in place and the actuator holds its position.

Servo Amplifier

The servo amplifier provides the power to drive the servo valve. There are two servo drive outputs in parallel providing redundancy in the control output. Each output connects to separate coils. Servo valve operation requires only one functioning coil. One output can short to ground or open without affecting the other servo drive output. If one servo drive output fails, the other output is able to drive the servo valve.

Dither Oscillator

The dither oscillator introduces an oscillation of small magnitude to the servo valve to help it overcome the effect of friction. In systems where valve position rarely changes, the dither oscillator prevents the valve from freezing in one position.

POSITION FEEDBACK

The are three parts to the position feedback block, the demodulator, the sample hold circuit and analog-to-digital converter (ADC).

Demodulator

The LVDT secondaries respond to the movement of the hydraulic actuator by generating a differential voltage that is proportional to the position of a transformer core that moves as the actuator moves. Since the LVDT secondary is linear, the induced voltage on the transformer secondary is calibrated with the full range of the throttle valve. There is a maximum and minimum differential voltage indicating a fully open or fully closed valve. A valve half (50 percent) open is at the null position (differential voltage is zero). The demodulator sums the LVDT secondary inputs (which are out of phase) and the result is a DC offset that represents the actuator position. The position feedback signal passes from the demodulator output to the sample hold circuit.

Sample Hold Circuit

The sample hold circuit samples the demodulator output 1000 times per second. The position feedback travels directly from the sample hold output to the position error circuit, completing the control portion of the feedback loop.

Analog-to-Digital Converter

This portion of the position feedback circuitry converts the analog feedback signal to a digital value. The position feedback passes from the ADC converter to the data buffers, to the microcontroller, to the slave expander bus and finally to the MFP.

LVDT OSCILLATOR

The LVDT oscillator (frequency selectable) supplies an excitation voltage to the LVDT primary. See Figure 2-4. The excitation voltage on the primary causes the secondary of the LVDT to induce a differential voltage indicating actuator position. This output has selectable gains. Setting a dipswitch adjusts the operating range of the LVDT excitation voltage to allow a maximum range of output voltage on the LVDT secondaries.

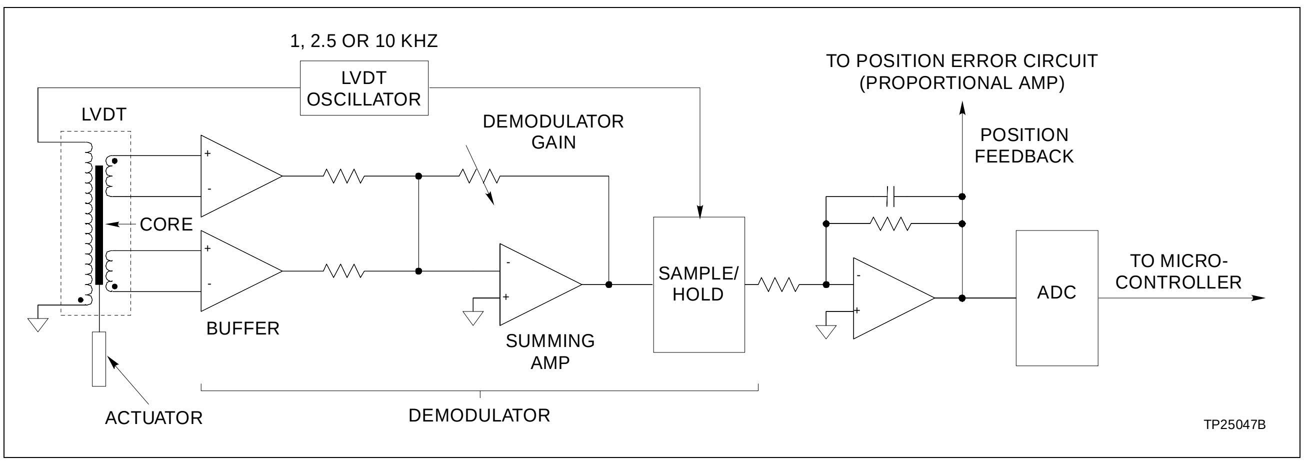


Figure 2-4. Position Feedback Circuit

DIGITAL I/O

If the HSS loses communication with the MFP, the manual control circuitry enables the operator to manually change actuator position. The HSS provides two +24 VDC isolated digital inputs as raise/lower commands from a manual station (pushbuttons, contacts, etc.). These inputs connect to the microcontroller. The microcontroller outputs a position demand to the servo valve when the operator activates the contacts. Trip bias is the third digital input. The trip bias input signal is sent to the position error circuit. See Figure 2-3. Activating the trip bias input drives the actuator to the 0 percent position (fully closed) for emergency shutdown. Emergency manual is an isolated output that provides a connection for an external indicator (LED) or alarm. The indicator notifies the operator that the module is in the emergency manual mode. Figure 2-5 shows a schematic of a typical isolated digital input circuit.

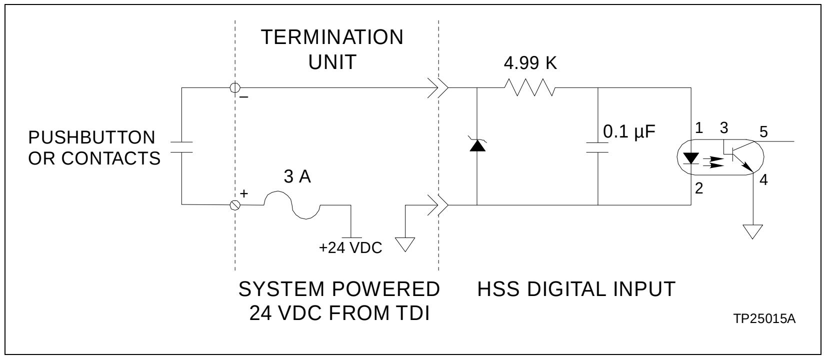


Figure 2-5. Typical Digital Input Circuit

SECTION 3 - INSTALLATION

INTRODUCTION

This section covers the proper handling of electrostatic sensitive devices, preliminary switch settings, termination unit or module installation, slave module installation and configuration. The steps in this section prepare the module for the calibration and tuning procedures in Section 4.

HANDLING

NOTE: Always use Bailey's Field Static Kit (P/N 1948385A1 - wrist strap, ground cord assembly, alligator clip) when working with modules. The kit connects a technician and the static dissipative work surface to the same ground point to prevent damage to the modules by electrostatic discharge.

Special Handling

The slave uses electrostatic sensitive (ESD) devices. Follow these handling procedures:

1. Keep the module in the special antistatic bag until you are ready to install it in the system. Save the bag for future use.

2. Ground the antistatic bag before opening.

3. Ground all devices that connect to the module before using them.

4. Avoid touching the circuitry when handling the modules.

General Handling

1. Examine the module immediately to verify that there is no damage from shipping.

2. Notify the nearest Bailey Controls sales office of any damage.

3. File a claim with the transportation company for any damage to the shipment.

4. Use the original packing material and container to store the module.

5. Store the module in an environment of good air quality and free from temperature and moisture extremes.

INSTALLING THE PROCESS HARDWARE

To install the throttle valve, hydraulic actuator, servo valve and LVDT:

CAUTION	**Only qualified personnel should install the throttle valve, hydraulic actuator, servo valve and linear variable differential transformer. Improper installation can cause damage to plant equipment, reduce plant performance and compromise the safety of plant personnel.**
ATTENTION	**Seul le personnel qualifie doit installer la soupape modulatrice, l'actionneur hydraulique, la soupape de pilotage et le transformateur lineaire a differentiel variable. Une installation inadequate pourrait endommager l'equipement en chantier, reduire les performances de l'usine et mettre en jeu la securite du personnel.**

1. Follow the manufacturers' directions and recommendations for installation.

2. Use the size and type of cabling the manufacturer recommends.

INSTALLING THE TERMINATION UNIT OR MODULE

For information about installing process wiring and the digital input termination unit (TDI) or digital input termination module (IDI), refer to the TDI or IDI termination instruction. Appendix B and Appendix C contain a quick reference of termination unit/module information. To install the termination unit or module and field wiring:

Termination Unit Installation

1. Configure the dipshunts on the termination unit.

2. Install the termination unit on the termination unit panel and secure into place with two screws.

3. Connect the wiring from the servo valve, linear variable differential transformer and digital I/O to the termination unit.

4. Connect the hooded end of the NKTU01/12 cable to the rear of the module mounting unit (MMU) slot for the HSS. Connect the other end of the cable to the P1 connector on the termination unit.

5. If digital I/O is system powered, wire the I/O common to the DC common bus bar at the bottom of the cabinet using a 14 AWG wire.

6. Connect a 14 AWG wire from E1 or E2 to a source of +24 VDC within the cabinet.

Termination Module Installation

1. Configure the jumpers on the termination module.

2. Connect one end of NKTM01 or NKTU02/12 cable to the rear of the termination mounting unit (TMU) slot for the termination module. Connect the other end of the cable to the rear of the MMU slot (backplane) for the HSS.

3. Insert the termination module in the assigned slot of the TMU leaving the terminals next to the faceplate exposed.

4. Connect the wiring from the servo valve, linear variable differential transformer and digital I/O to the termination module.

5. Push the module into the TMU until it seats in the termination module connector.

CAUTION	**Only qualified personnel should configure these switches. Damage or misoperation could occur if switches are improperly configured.**
ATTENTION	**La configuration de ces interrupteurs ne devrait etre effectuee que par un personnel qualifie. Des dommages ou une mauvaise operation pourraient resulter d'une mauvaise configuration des interrupteurs.**

INITIAL SWITCH SETTINGS

The HSS has seven switches that the user must configure. Switch settings are application dependent. The information in this section covers the switch settings needed for initial installation. Complete the steps in this part of the installation procedure to prepare the module for calibration and tuning.

Switch S1 - Slave Expander Bus Address

Switch S1 is an eight position dipswitch. The user sets the slave expander bus address at any unused address value from 0 to 63. Switch positions 1 and 2 must always be in the CLOSED position. Use positions 3 through 8 to set the address. Table 3-1 shows examples of switch settings for the slave expander bus address. See Figure 3-1 for the location of S1 on the HSS module. Record the slave expander bus address in the user setting column.

Table 3-1. Slave Expander Bus Address - Example Settings

Example Settings									
Example Address	**Switch Position**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Binary Value	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
15		0	0	0	0	1	1	1	1
32		0	0	1	0	0	0	0	0
63		0	0	1	1	1	1	1	1

User Settings									
Assigned Address	**Switch Position**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Binary Value	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**

NOTE: 1 = Open (off), 0 = Closed (on)

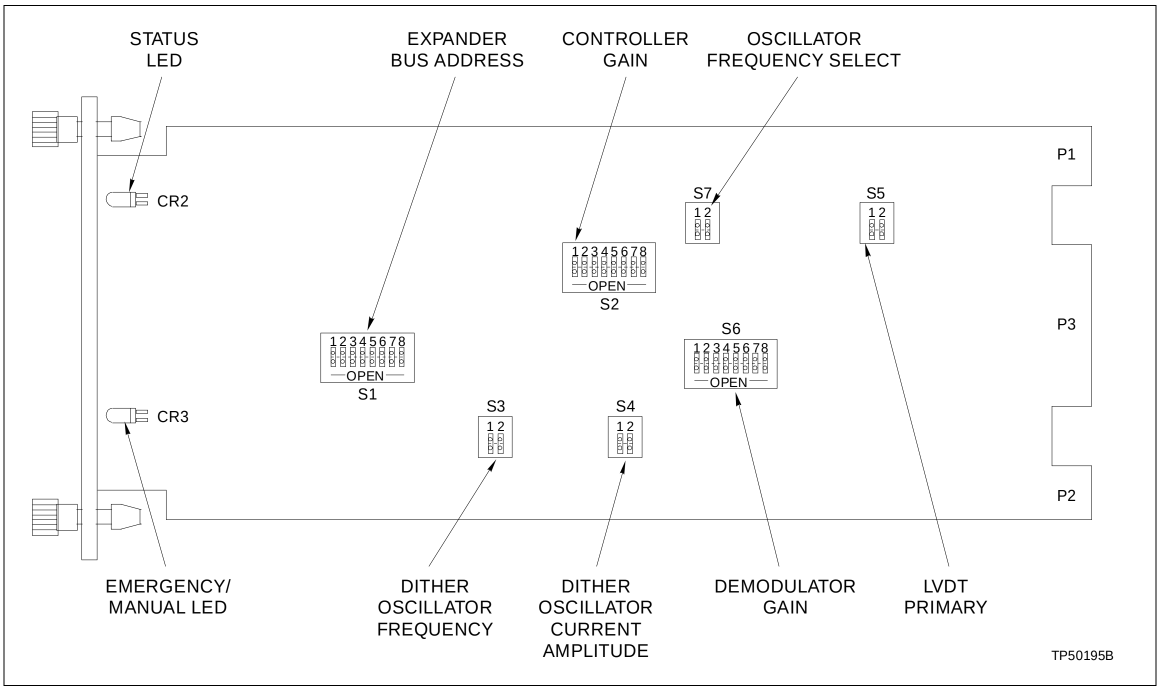


Figure 3-1. Switch Locations on the HSS

Switch S2 - Controller Gain

This switch is an eight position switch that sets the gain of the proportional amplifier. This amplifier compares position demand to position feedback and outputs the difference of those signals. The gain affects the response of the control loop. ***CONTROLLER TUNING*** in Section 4 explains the procedure to determine the proportional amplifier gain that gives the best frequency response. To initially set the gain for installation, close pole 8 on S2 (gain of 1.10).

Table 3-2. S2 Controller Gain

Close Switch	For a Gain of	User Setting
1	20.50	
2	18.25	
3	15.05	
4	13.10	
5	10.00	
6	5.00	
7	2.01	
8	1.10	

NOTE: Closing a switch position will select the corresponding gain. Close only one switch at a time. All other switch positions must remain open. There are eight possible controller gains. For example: For a gain of 5.00, leave switch position 6 CLOSED and all others OPEN.
1 = Open (off), 0 = Closed (on)

Switch S3 - Dither Oscillator Frequency

Switch S3 is a two position switch that determines the dither oscillator frequency. Set the dither oscillator frequency to the value the manufacturer of the servo valve recommends. To set the dither oscillator frequency:

1. Refer to the servo valve specifications for the recommended dither oscillator frequency.

2. Refer to Table 3-3 for switch settings and set S3 accordingly.

Table 3-3. S3 Dither Oscillator Frequencies

Switch Position		Frequency	User Setting
1	2		
Closed	Open	300 Hz (high)	
Open	Closed	200 Hz (low)	

NOTE: Do not leave both switches open or closed; circuit will not function properly.
1 = Open (off), 0 = Closed (on)

Switch S4 - Dither Oscillator Current Amplitude

Switch S4 is a two position switch that sets the current amplitude of the dither circuit. Set the dither oscillator current amplitude to the value the manufacturer of the servo valve recommends. This switch also allows the user to disable the dither oscillator if required. To set the dither oscillator amplitude:

1. Refer to the servo valve specifications for the recommended dither oscillator current amplitude.

2. Refer to Table 3-4 for switch settings and set S4 accordingly.

Table 3-4. S4 Dither Oscillator Amplitude

Switch Position		Amplitude	User Setting
1	2		
Closed	Open	2.4 mA	
Open	Closed	1.2 mA	
Open	Open	Dither Disabled	

NOTE: Do not leave both switches closed; the circuit will not function properly.
1 = Open (off), 0 = Closed (on)

Switch S5 - LVDT Primary Voltage Amplitude

Switch S5 is a two position switch that sets the linear variable differential transformer primary excitation voltage. Set the amplitude of the LVDT primary excitation voltage to the value the manufacturer recommends. To set the LVDT excitation voltage:

1. Refer to the LVDT specifications for the recommended LVDT primary excitation voltage.

2. Refer to Table 3-5 for switch settings and set S5 so that the excitation voltage is within the manufacturer's specifications.

Table 3-5. S5 LVDT Excitation Voltage

Switch Position		Voltage	User Setting
1	2		
Closed	Open	14.0 Vp-p (typical)	
Open	Closed	8.0 Vp-p (typical)	
Closed	Closed	6.0 Vp-p (typical)	

NOTE: Do not leave both positions in the open position; the switch will not function properly.
1 = Open (off), 0 = Closed (on)

Switch S6 - Demodulator Gain

Switch S6 is an eight position switch that sets the demodulator gain. The demodulator gain amplifies the feedback signal so that the peak to peak span of the feedback signal is the full range of the 16 bit resolution analog-to-digital converter (ADC). The calibration procedure in Section 4 explains how to set the demodulator gain to operate over the range of ADC resolution. Refer to Table 3-6 for switch settings. To initially set the demodulator gain for installation, close pole 8 on S6 (gain of 2).

Table 3-6. S6 Demodulator Gains

Close Switch	For a Gain of	User Setting
1	150	
2	100	
3	75	
4	49	
5	20	
6	10	
7	5	
8	2	

NOTE: To select the **Gain** close the corresponding switch position. All other switches should be OPEN. For example: For a gain of 100, close switch position 2 and all others remain OPEN.
1 = Open (off), 0 = Closed (on)

Switch S7 - LVDT Oscillator Frequency

Switch S7 is a two position switch that sets the linear variable differential transformer primary excitation voltage frequency. Set the LVDT oscillator frequency to the frequency specified by the manufacturer. To set the LVDT oscillator frequency:

1. Refer to the LVDT specifications for the recommended LVDT primary excitation voltage frequency.

2. Refer to Table 3-7 for switch settings and set S7 so that the LVDT oscillator meets the manufacturers specifications.

SLAVE MODULE INSTALLATION

To install the slave module in the module mounting unit:

1. Locate the module mounting unit slot assignment for the module.

Table 3-7. S7 LVDT Oscillator Frequency

Switch Position		Frequency	User Setting
1	2		
Open	Open	1000 Hz	
Open	Closed	2500 Hz	
Closed	Open	10 kHz	

NOTE: 1 = Open (off), 0 = Closed (on)

2. Check the slave expander bus dipshunt socket on the backplane of the MMU. The dipshunt must be installed with all pins shorted. This provides a communication path from the master module to the slave module.

3. Align the top and bottom edges of the circuit card with the top and bottom rails of the assigned slot in the MMU.

4. Slide the module into the slot. Push until the module is seated in the backplane connector. Turn the two thumbscrews on the faceplate a half turn until the module locks in place.

CONFIGURATION

To work with the HSS, the MFP or MFC must have function code 150 in its configuration. To configure the processor or controller module:

1. Refer to the ***Function Code Application Manual*** for configuration instructions.

2. Configure the processor or controller module with function code 150, specifications S1 and S2.

3. Leave the remaining specifications at their default value. They require modification during the module calibration procedure.

SECTION 4 - CALIBRATION

INTRODUCTION

This section covers the module calibration procedure, analog control loop tuning theory and the controller gain tuning procedure. Completing the steps in this section ensures accurate positioning of the turbine throttle valve and the best possible frequency response. Complete the steps in this section before placing the HSS in operation.

INITIAL CALIBRATION

Before beginning the module calibration procedure:

1. Obtain the following documents and have them on hand:

   a. The ***Function Code Application Manual***.

   b. The instruction manual for the operator interface (i.e., PCV, OIS, CTM).

2. Verify that the following conditions exist:

   a. The valve (for turbine hydraulic system) must be in the controlling position and functioning properly.

   b. The controller or processor module has function code 150 in its configuration.

   c. The HSS controller gain (switch 1) is set to 1 (pole 8 is closed).

   d. The HSS demodulator gain (switch 6) is set to 2 (pole 8 is closed).

   e. The turbine should be off-line.

   f. If the turbine is on-line, there must be other controlling valves operating to compensate for position changes of the valve in calibration.

To calibrate the HSS:

1. 1. Verify that the block address specified in S7 contains the proper number of calibration cycles (from 1 to 8).

2. Verify that the block address specified in S6 contains the desired calibration cycle time. Values are 1 (30 seconds), 2 (60 seconds), 3 (35 minutes), 4 (70 minutes). 30 and 60 seconds

are fast cycle times and are not recommended if the turbine is on-line.

3. Go to the block address specified in S3. Set the calibration command bit to 1. This places the HSS in the calibrate mode.

4. Read the value of S8 with the valve in the 0 percent position (closed).

5. If the value of S8 is between 0 and - 9 VDC, remove the HSS and increase the demodulator gain (switch 6) one position. For example, if the gain is 2 (position 8 closed), change the gain to 5 (close position 7, open position 8).

6. Reinsert the HSS in the MMU.

7. Continue reading S8 and increase the demodulator gain until S8 displays a value of - 9 VDC to - 10.0 VDC. Record the final gain value in the space provided in Table 3-6.

8. Go to the block address specified in S5. Set the LVDT null bit to 1.

9. Go to the block address specified in S4. Set the GO/HOLD select bit to 1.

10. Monitor the output block (n+1) until it has a value of 1. This indicates the actuator is at the null point.

11. Make the necessary adjustments to the servo valve and the LVDT position to adjust the actuator to its mechanical null position.

For maximum LVDT linearity, the LVDTs null point should occur at the actuators mid travel position. When S4 is in the GO mode, the actuator ramps to and holds at the LVDT null point (LVDT secondaries have equal voltages). While the actuator is held at the LVDT null point, the mechanical zero on the LVDT can be adjusted until the actuator is at its mid-travel position.

12. After LVDT zeroing, turn the null check mode off (S5=0). The HSS drives the actuator to the 100 percent position at the selected stroke time (S6). While the actuator is held against the 100 percent end of travel, function code 150 stores the LVDT differential voltage at 100 percent in specification (S9).

After recording the 100 percent reading, the HSS drives the actuator to the 0 percent actuator position at the selected stroke time. While the actuator is held against the 0 percent end of travel stop, function code 150 records the LVDT differential voltage at 0 percent in specification (S8). After recording the 0 percent reading, the actuator moves at the selected stroke time to the position demand from the MFP. The 100 percent to 0 percent cycle repeats if the number of calibration cycles specified in S7 is more than one. When the calibration cycles are complete the actuator ramps to the position demand from the MFP.

Allow the cycle to complete.

Specifications S8 (0 percent) and S9 (100 percent) store the value of the LVDT differential voltages determined during the calibration cycle. The new values replace the initial values or previous calibration values.

CONTROLLER TUNING

Analog Control Tuning Theory

Because there are many aspects of a control loop that affect the system response, it is impractical to develop a mathematical model to calculate the optimum controller gain. Control loop characteristics that affect the system response are:

1. The characteristics of the servo valve, LVDT and hydraulic actuator such as operating specifications, impedance tolerances, line losses, hydraulic system efficiency, actuator spring tolerance and transformer performance.

2. Lag time inherent in a closed loop (feedback) control system.

Response time and system stability are the primary concerns in determining the controller gain. The objective of analog control tuning is to have a high frequency response while maintaining system stability. The hydraulic servo slave is a proportional plus integral plus derivative controller (PID). PID controllers readily meet the analog control tuning objectives. The derivative action of PID controllers increases and stabilizes the frequency response by compensating for lag time in the control loop.

PID controllers are complex and tuning them is difficult. The most common method (90 to 95 percent of the time) of tuning PID controllers is the trial and error or practical method. [1] The HSS is designed with the derivative and integral action constant (not tuneable). Tuning is accomplished by changing the proportional gain. Increasing the proportional gain decreases system stability and increases frequency response. The practical method finds the gain that is one level below the gain that causes instability (oscillation).

1. Ralph K. Johnson, Analog Control Techniques and Tuning, TP89-2 (Wickliffe: Bailey Controls Co., 1989).

Tuning the Controller Gain

The practical method of setting controller gain requires an individual with turbine control experience. The individual tuning the system should be familiar with plant operation under normal conditions, know turbine start-up procedures and have experience in tuning control systems. In cases where the valve is a distance from the control cabinet or separated by barriers, two people are needed to tune the system. One person observes the valve operation while the other person sets the controller gain and enters position demand. Communication by telephone or intercom is recommended. The radio frequency interference from walkie-talkies can cause problems with the control system. Exercise extreme care if you use a walkie-talkie. When keying the unit, the operator should be at least two meters away from the cabinet and the cabinet doors closed.

Before tuning the controller gain, verify that the following conditions exist:

1. Calibration of the HSS, hydraulic actuator and LVDT is complete.

2. The controller gain is set to 1 (switch 2 pole eight is closed). Refer to Table 3-2 for controller gain switch settings.

3. The calibration command bit in the block address specified in S3 is set to 0 (normal operation).

4. The GO\HOLD bit in the block address specified in S4 is set to 0 (HOLD).

5. The turbine is off-line.

To tune the controller gain:

1. Enter position demands (via the operator interface) of 25 percent, 50 percent, 75 percent and 90 percent, opening the valve. Observe the response of the throttle valve at each demand level. The valve should respond without oscillating at any level of demand.

2. Enter position demands (via the operator interface) of 25 percent, 50 percent, 75 percent and 90 percent, closing the valve. Observe the response of the throttle valve at each demand level. The valve should respond without oscillating at each level of demand.

3. Check valve operation.

a. If the valve operates smoothly at all demand levels.

• 1. Remove the HSS and raise the controller gain (switch 2) to the next setting. For example, if the gain is 1 (position 8 is closed), change the gain to 2 (close position 7, open position 8).

2. Reinsert the module in the MMU.

3. Repeat steps 1 and 2.

b. If the valve oscillates at any demand level.

1. Remove the HSS and lower the gain (switch 2) to the next setting. For example, if the gain is 13 (position 4 is closed), change the gain to 10 (close position 5, open position 4).

2. Reinsert the module in the MMU.

3. Go to step 4.

4. Repeat steps 1 and 2 to check valve operation at each demand level. The controller gain is set when you reach this point and have smooth valve operation.

5. Record the date, time, gain setting and the names of the personnel tuning the controller in the space provided in Table 4-1. Update the controller tuning log when making any adjustment in controller tuning.

NOTE: Do not start operating the HSS until S3 of function code 150 is reset to 0. A calibration cycle could start if the module is reset and S3 is set to 1.

ON-LINE CALIBRATION

On-line calibration is possible when there are other controlling valves on-line that are operating properly. The hydraulic servo slaves for those valves will compensate for the repositioning of valve and actuator in calibration. To do an on-line calibration:

Refer to ***INITIAL CALIBRATION*** and do the steps of the servo valve and actuator calibration procedure.

Table 4-1. Controller Tuning Log

Date	Time	Gain Setting	Names of Personnel

SECTION 5 - OPERATING PROCEDURES

INTRODUCTION

This section explains how to place the hydraulic servo slave (HSS) in operation. This section includes information about the HSS faceplate indicators, system start-up and operation and manual operation.

FACEPLATE INDICATORS

Two LEDs are visible through the faceplate of the HSS, the status LED and the emergency manual LED. Refer to Table 5-1 for an explanation of the LED states.

Table 5-1. LED States

Status LED	Emergency Manual LED	Condition
Red	On	Emergency manual mode, communications with MFP lost.
	Off	HSS failure, machine fault timer timeout.
Green	On	MFP communications okay, but HSS in emergency manual mode.
	Off	Normal operation
Blank	On	MFP communications lost, in emergency manual mode.
	Off	HSS module failure. Loss of power.

START-UP AND NORMAL OPERATION

Only qualified personnel should perform plant start-up and operation. The following steps explain HSS start-up and operation:

1. Start the turbine following the plant start-up procedure.

2. Enter a turbine speed demand or load demand setpoint via the operator interface.

3. Operation continues according to the system control strategy in the MFP configuration.

MANUAL OPERATION

Emergency Manual Mode

Operation enters the emergency manual mode when a MFP communication failure occurs. The emergency manual LED on the module faceplate indicates that the module is in the manual mode of operation. Refer to Table 5-1 to determine the module status using the faceplate LEDs. Figure 5-1 shows the LED locations on the module faceplate. To manually position the throttle valve:

1. Monitor the turbine speed or load through the operator interface.

2. Refer to your plant operating procedure to determine the actuator position needed to maintain turbine speed.

3. To maintain the load (or speed) demand, adjust the hydraulic actuator position by activating the raise or lower

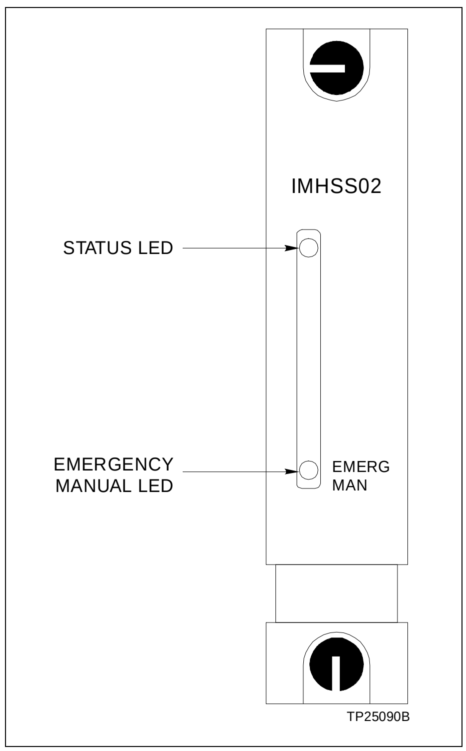


Figure 5-1. Faceplate Indicators

contacts. The raise contact opens the valve while the lower contact closes the valve.

NOTE: The HSS enters the emergency manual mode when it loses communications with the MFP. When the MFP re-establishes communication with the HSS, a bumpless transfer of operation occurs and causes the HSS to exit the emergency manual mode. The MFP resumes automatic operation from the valve position held during manual operation.

Emergency Trip

Emergency trip provides failsafe operation of equipment and safety to personnel by providing a way to drive the throttle valve closed in an emergency. The trip bias circuit overrides position control from the HSS microcontroller and drives the valve closed. To drive the valve closed, close the trip bias switch (or pushbutton) to apply +24 VDC to the trip bias digital input.

SECTION 6 - TROUBLESHOOTING

INTRODUCTION

This section explains how to troubleshoot basic module and system failures. This section includes flowcharts and tables containing troubleshooting procedures and corrective action.

HOW TO USE THIS SECTION

You can effectively troubleshoot a failure by using the flowcharts to isolate the failure. After locating the failure, refer to the text or other documents for more information about the failure and the corrective action. You will need product instructions for the controller or processor module, the operator interface (i.e., OIS, PCV, CTM/CTT) and the ***Function Code Application Manual***. Contact the manufacturer for information about the process hardware in the control loop.

The first part of this section covers off-line failures. If the failure is preventing calibration, tuning or module start-up, go to ***OFF-LINE FAILURE*** and the steps of the troubleshooting procedure. The second part covers failures during operation. If the failure occurs during operation, go to ***ON-LINE FAILURE*** and the steps of the troubleshooting procedure.

> **NOTE:** Troubleshooting involves physical contact with the system, including the handling of boards with electrostatic sensitive devices. To avoid creating additional problems while troubleshooting, always use Bailey Controls Field Static Kit (P/N 1948385A1) when working with the modules. The kit is designed to connect a technician and the static dissipative work surface to the same ground point to prevent damage to the modules by electrostatic discharge.

OFF-LINE FAILURE

This part of the troubleshooting section covers off-line failures and how to troubleshoot those failures. Off-line failures occur during module calibration and are a result of improper or incomplete installation or calibration.

If the HSS fails to calibrate after completing the installation procedure:

1. Locate the cause of the failure using the troubleshooting flowchart in Figure 6-1.

2. Refer to Table 6-1 for the corrective action.

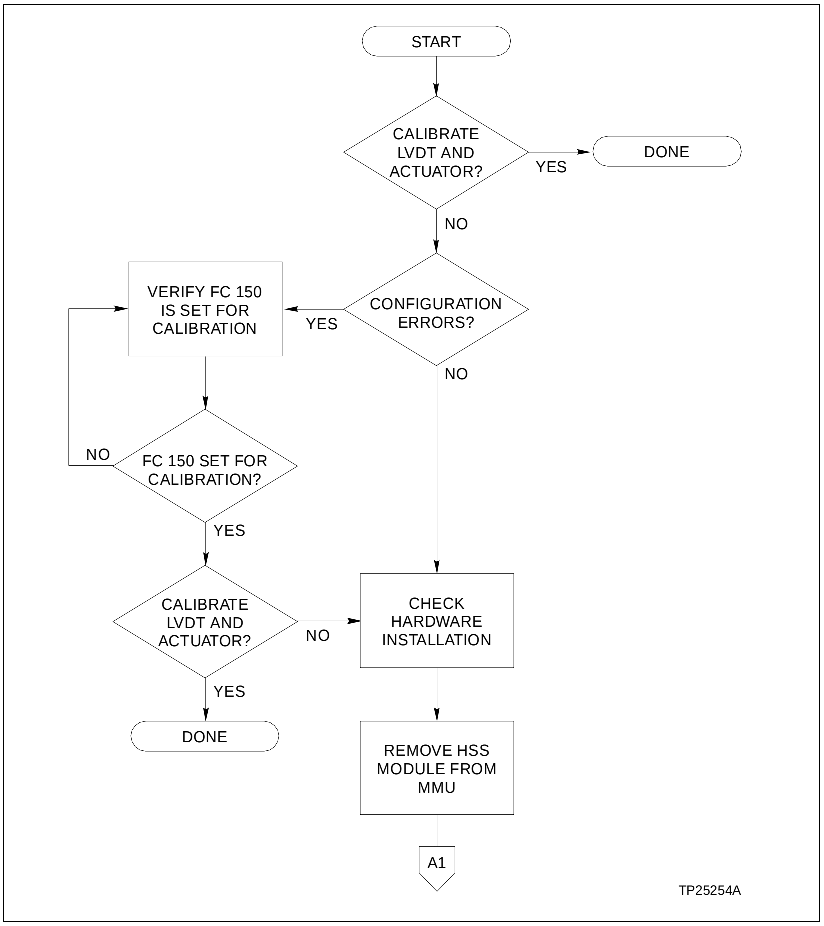


Figure 6-1. Off-Line Failure Troubleshooting Flowchart (Page 1 of 3)

3. If the HSS continues to fail to calibrate and you cannot locate the failure using the troubleshooting flowchart or the steps in Table 6-1, replace the hydraulic servo slave module.

4. If replacing the module does not correct the problem call Bailey Controls for assistance.

ON-LINE FAILURE

This part of the troubleshooting section covers on-line failures and how to troubleshoot them. On-line failures are those that occur during the course of normal operation.

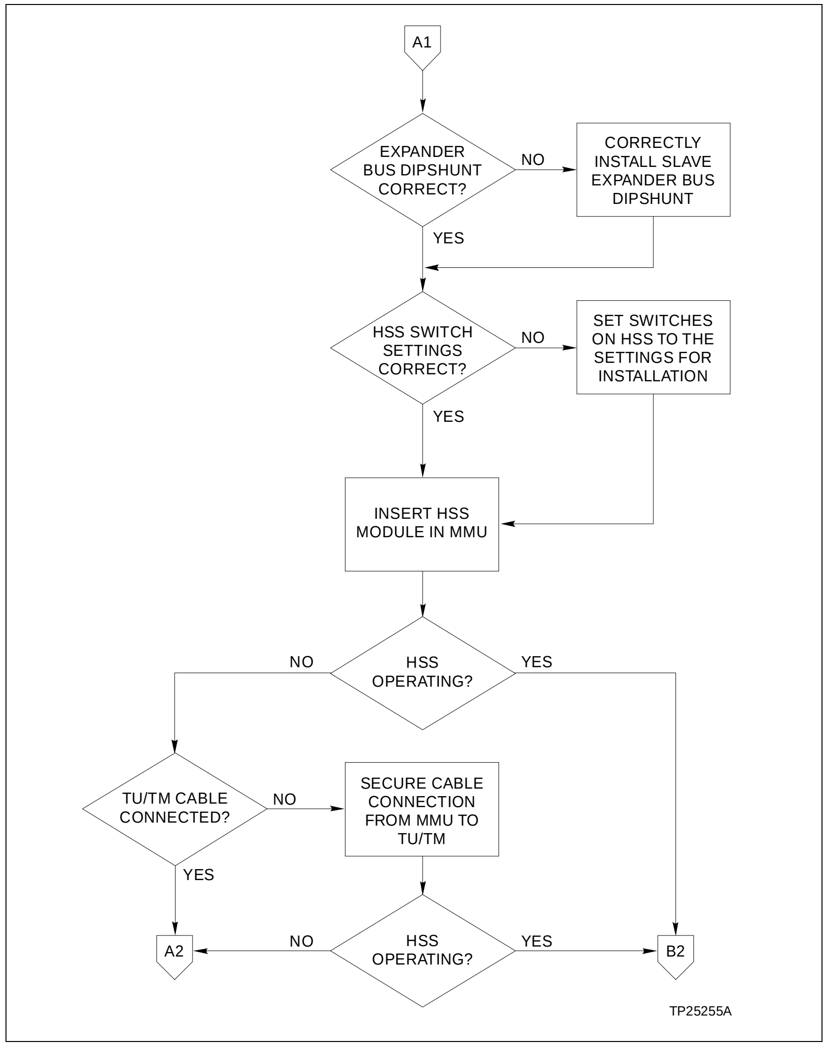


Figure 6-1. Off-Line Failure Troubleshooting Flowchart (Page 2 of 3)

Module Failure

To check for a module failure:

1. Check the LEDs on the faceplate of the HSS module.

2. Refer to Table 6-2 for a listing of LED states that indicate a module failure. For a complete list of LED states refer to Table 5-1.

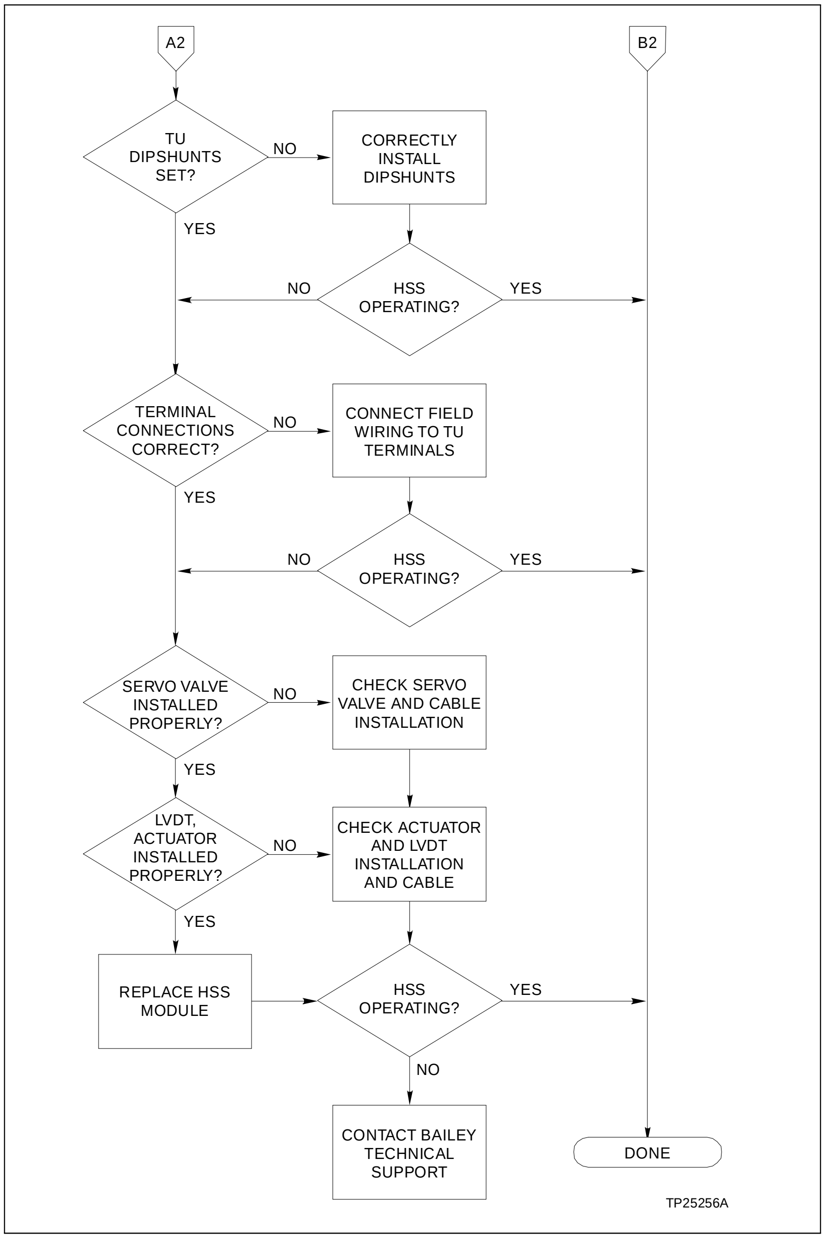


Figure 6-1. Off-Line Failure Troubleshooting Flowchart (Page 3 of 3)

Table 6-1. Troubleshooting On-Line Failures

Problem	Cause	Action
HSS fails to calibrate	Configuration errors	Check the specifications for function code 150. Verify that function code 150 is set for calibration.
HSS fails to calibrate and there are no configuration errors	Improper installation	Check the installation of the HSS and related hardware. 1. Remove the HSS and check the slave expander bus dipshunt. All the dipshunt pins should be shorted. 2. Check the switch settings on the HSS. Refer to ***INITIAL SWITCH SETTINGS*** in Section 3 to verify that the switches are properly set for module installation. 3. Reinsert the module in the MMU. Refer to ***SLAVE MODULE INSTALLATION*** in Section 3 for instructions. 4. Check the termination cable. A. Verify that the cable is connected to the correct slot on the MMU backplane. B. Verify that the cable connects P3 on the HSS to P1 on the termination unit or P3 on the termination module. 5. Check the dipshunt settings on the termination unit or the jumper settings on the termination module. Refer to Appendix B or Appendix C for HSS dipshunt or jumper configuration. 6. Check the process wiring. Verify that the process wiring is connected to the correct terminals on the TU or TM. Refer to Appendix B or Appendix C for terminal assignments. 7. Check the installation of the servo valve, hydraulic actuator, LVDT and related hardware. Contact the manufacturer for information about the servo valve, hydraulic actuator and LVDT.
HSS fails to calibrate and there are no configuration or installation errors	Process hardware	Check the process hardware.
No servo drive from the servo amplifiers	Bad connection to the servo valve, defective servo valve	Check the servo valve. 1. Connect an oscilloscope to TB4 terminal 1 (terminal 32 on the TM) and do steps 2 - 6. Then connect the oscilloscope to TB4 terminal 3 (terminal 30 on the TM) and repeat steps 2 - 6. Ground the oscilloscope on the system common. 2. Enter a position demand to change the actuator position.

Table 6-1. Troubleshooting On-Line Failures (continued)

Problem	Cause	Action
No servo drive from the servo amplifiers (continued)	Bad connection to the servo valve, defective servo valve	3. Verify that there is a servo drive and return signal for each servo output. 4. If there is no servo valve drive signal, check the continuity of the connecting cables. 5. If the connecting cables are open or show an unusually high impedance, replace the cables. 6. If the cable continuity is good and there is no servo drive output, check the servo valve and replace it if defective.
No LVDT primary excitation voltage	Bad LVDT, bad cable	Check the LVDT primary. 1. Connect an oscilloscope to TB1 terminal 1 (terminal 17 on the TM). Ground the oscilloscope on the system common. 2. Verify that there is an excitation voltage on the primary side of the LVDT at the selected frequency. 3. Connect the oscilloscope to TB1 terminal 2 (terminal 16 on the TM) Ground the oscilloscope on the system common. 4. Verify that there is a return signal on the primary side of the LVDT at the selected frequency. 5. If there is no LVDT excitation signal, check the continuity of the connecting cable. 6. If the connecting cables are open or show an unusually high impedance, replace the cables. 7. If the cable continuity is good and there is no LVDT excitation, check the LVDT and replace if defective.
No LVDT secondary response	Bad connection to the LVDT, bad transformer	Check the LVDT secondary. 1. Connect an oscilloscope differentially across TB1 terminals 3 and 4 and do steps 2 through 5. Then connect the oscilloscope differentially across TB1 terminals 5 and 6 and repeat steps 2 through 5. 2. Enter a position demand to change the actuator position. 3. Verify that there is a differential voltage on each LVDT secondary at the selected frequency. The differential voltage will change during a position demand. 4. If there is no differential voltage on the LVDT secondaries, check the continuity of the connecting cables. 5. If the cable continuity is good and there is no differential voltage on the LVDT secondaries, check the LVDT and replace if defective.
HSS fails to calibrate, all process hardware checks good, there are no configuration errors	HSS failure	Replace the HSS module.
Replacing the HSS fails to correct the calibration failure		Contact Bailey Controls for assistance.

Table 6-2. Module Failure Indicators

Status LED	Emergency Manual LED	Condition
Red	Off	HSS failure, Machine Fault Timer timeout.
Blank	Off	HSS module failure. Loss of power.

Restoring Operation

To restore module operation:

1. Use the troubleshooting flowchart in Figure 6-2 to locate the problem.

2. Refer to Table 6-3 for corrective action.

3. If the HSS module continues to fail after completing steps 1 and 2, replace the module.

4. If replacing the module does not correct the problem contact Bailey Controls for assistance.

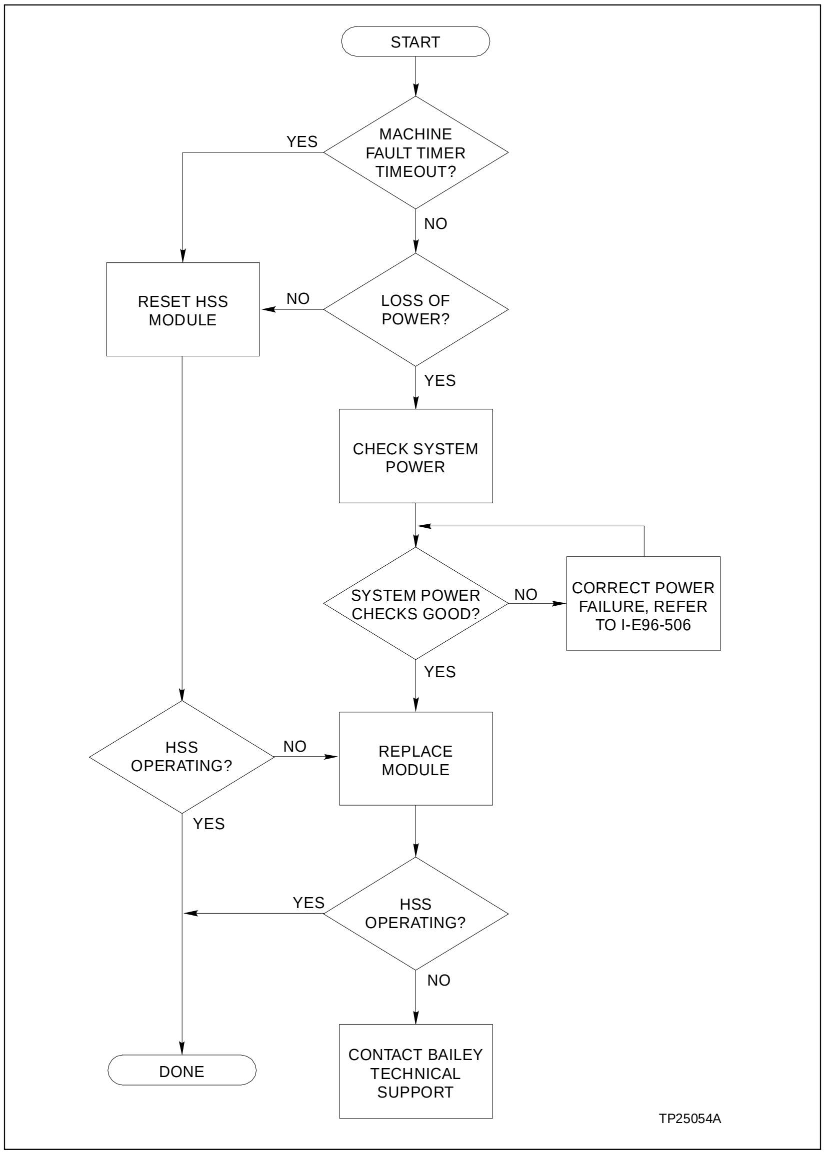


Figure 6-2. On-Line Failure Troubleshooting Flowchart

Table 6-3. Troubleshooting On-Line Failures

Condition	LED States	Action
Machine fault timer timeout	Status - Red Emerg. Man. - Off	Reset the module. 1. Turn the thumbscrews on the faceplate a half turn to unlock the module. 2. Pull on the module faceplate until the module disconnects from the MMU backplane connector. 3. Reseat the module by pushing on the module faceplate until the module connects with the MMU backplane connector. 4. Turn the faceplate thumbscrews a half turn until the module locks in place.
Reset module and machine fault timer timeout continues	Status - Red Emerg. Man. - Off	Replace the HSS module. 1. Remove the slave module. 2. Turn the faceplate thumbscrews a half turn to unlock the module. 3. Pull on the module faceplate, remove the module from the MMU. 4. Insert a good slave module. 5. Return to Section 3 and Section 4 and the steps of the installation and calibration procedure.
Loss of power	Status - Blank Emerg. Man. - Off	Remove the slave and check the system Refer to Section 5 of the ***Modular Power System Instruction*** for the system power troubleshooting procedure.
Loss of power and system power checks good	Status - Blank Emerg. Man. - Off	Insert a good slave. Return to Section 3 and Section 4 and the steps of the installation and calibration procedure.
Actuator positioning alarm and possible bad primary status	Status - Green Emerg. Man. - Off	Measure the LVDT primary voltage. 1. If the measured oscillator voltage is less than 1.0 VRMS then the LVDT primary has failed. 2. If the voltage is greater than 1.0 VRMS then the LVDT primary is good and some other malfunction within the servo valve, actuator or related component has caused the error.
Actuator positioning alarm and possible bad primary status	Status - Green Emerg. Man. - Off	Measure the LVDT secondary voltages. 1. If no sine wave is present on one or the other LVDT secondary, that secondary output has failed. 2. If both secondaries have sine waves, then the LVDT secondaries are good and some other malfunction has caused the error.

SECTION 7 - MAINTENANCE

INTRODUCTION

The hydraulic servo slave requires minimal maintenance. The following maintenance schedule will ensure troublefree service.

NOTE: Only qualified personnel should perform maintenance.

MAINTENANCE

The HSS maintenance schedule is shown in Table 7-1. Perform these tasks at the specified intervals.

Table 7-1. Maintenance Schedule

Task	Interval
Recalibration of LVDT and actuator	Every plant shutdown or sooner if needed. Calibration can be done on-line.
Use a static safe vacuum cleaner to remove dust from: Modules Module Mounting Unit	Every 6 months or during plant shutdown, whichever occurs first.

REPAIR/REPLACEMENT PROCEDURES

The hydraulic servo slave is designed for long, troublefree service. There are no parts on the HSS that the user can service. If a failure occurs, refer to Section 6 for instructions to restore operation.

SECTION 8 - SUPPORT SERVICES

INTRODUCTION

Bailey Controls is ready to assist in the use and repairs of its products. Requests for sales and/or applications services along with installation, repair, overhaul and maintenance contract services should be made to the nearest sales office.

REPLACEMENT PARTS AND ORDERING INFORMATION

If you are making repairs at your own facility, replacement parts should be ordered through a Bailey Controls sales office. Provide the following information for parts orders:

1. Part description, part number and quantity.

2. Model, serial number (if applicable) and ratings of the assembly containing the ordered part.

3. Bailey Controls publication number and reference used in identifying the part.

When ordering standard parts from Bailey Controls, use the part number and description from the replacement parts section of the manual. Parts not having a commercial description in the replacement parts section must be ordered from a Bailey Controls sales office.

TRAINING

Bailey Controls has a modern training facility equipped to provide service and repair instructions. This facility is available for training of personnel. Contact a Bailey Controls sales office for information on available classes and scheduling.

TECHNICAL DOCUMENTATION

Obtain additional copies of this manual through the nearest Bailey Controls sales office. Extra copies are available at a reasonable charge.

APPENDIX A - QUICK REFERENCE MATERIAL

INTRODUCTION

Tables A-1 through A-3 list edge connector pin assignments for the hydraulic servo slave module.

Table A-1. Edge Connector P1 (Module Power) Pin Assignments

Pin	Signal	Pin	Signal
1	+5 VDC	2	+5 VDC
3	Unused	4	Unused
5	Common	6	Common
7	+15 VDC	8	-15 VDC
9	PFI	10	PFI
11	Unused	12	Unused

Table A-2. Edge Connector P2 (Slave Expander Bus) Pin Assignments

Pin	Signal	Pin	Signal
1	Data Bit 1	2	Data Bit 0
3	Data Bit 3	4	Data Bit 2
5	Data Bit 5	6	Data Bit 4
7	Data Bit 7	8	Data Bit 6
9	Bus Clock	10	Bus Sync
11	Unused	12	Unused

Table A-3. Edge Connector P3 (Process Interface) Pin Assignments

Pin	Signal	Pin	Signal
1	Servo 1 Common	A	Servo 1 Drive
2	Servo 2 Common	B	Servo 2 Drive
3	N/C	C	N/C
4	N/C	D	N/C
5	Raise Common	E	Raise_P
6	N/C	F	N/C
7	Trip Bias Common	H	Trip Bias_P
8	N/C	J	N/C
9	LVDT Primary Drive (-)	K	LVDT Primary Drive (+)
10	LVDT Secondary 1_2	L	LVDT Secondary 1_1

Table A-3. Edge Connector P3 (Process Interface) Pin Assignments (continued)

Pin	Signal	Pin	Signal
11	LVDT Secondary 2_2	M	LVDT Secondary 2_1
12	Simulation Mode COM	N	Simulation Mode OUT
13	Lower ~	P	Lower_P
14	N/C	R	N/C
15	Emerg Manual Common	S	Emergency Manual ~

APPENDIX B - DIGITAL I/O TERMINATION UNIT (NTDI01)

INTRODUCTION

The IMHSS02 uses an NTDI01 termination unit to terminate I/O signals. Dipshunts on the termination unit configure the I/O signals. The hydraulic servo slave (HSS) module provides one digital and four analog outputs, and three digital and two analog inputs for control of hydraulic actuators.

Figure B-1 shows the dipshunt and connector locations on the NTDI01 circuit board. Table B-1 shows how to strap the dipshunt strapping to configure your application. Figure B-2 shows the terminal assignment and polarity for each of the I/O signals. Refer to this figure when connecting field wiring to the NTDI01. Figure B-3 shows how to connect the termination cable from the NTDI01 to the IMHSS02.

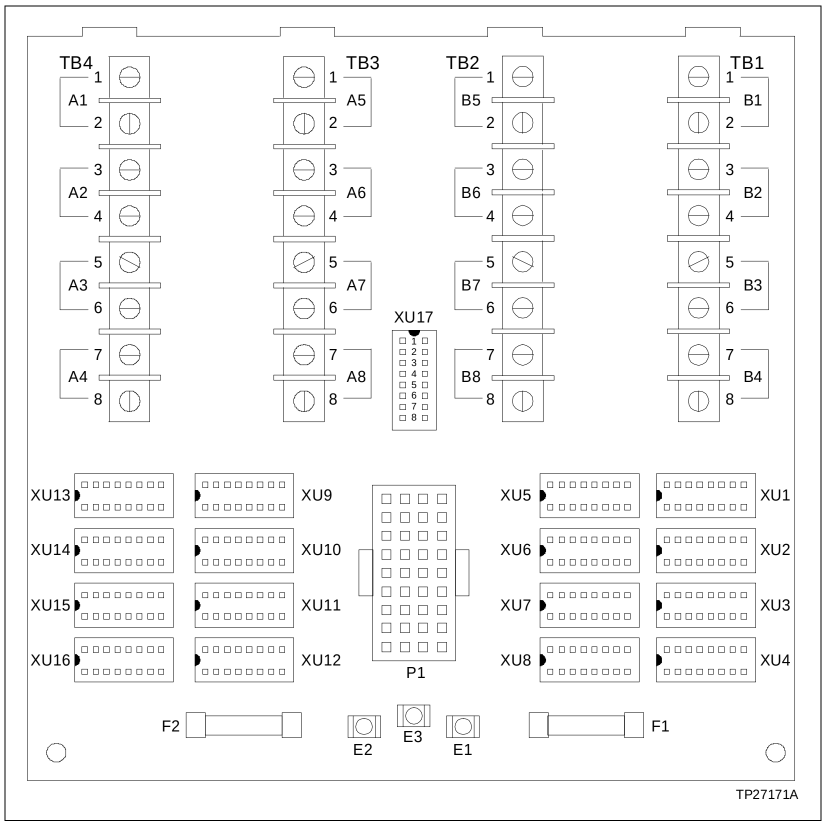
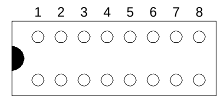
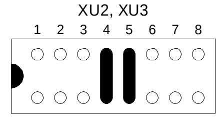
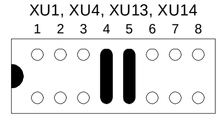
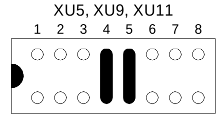
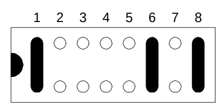
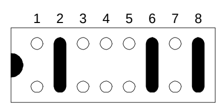
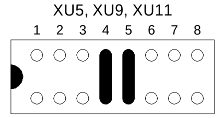
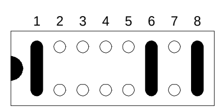
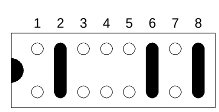


Figure B-1. NTDI01 Dipshunt and Connector Locations

Table B-1. NTDI01 Dipshunt Configuration for the HSS

Application/ Signal Type	Dipshunt Configuration
All Types	XU17 
Analog Inputs	
LVDT Secondary 1 LVDT Secondary 2	XU2, XU3 
Analog Outputs	
LVDT Primary Drive Simulation Mode Servo 1 Drive Servo 2 Drive	XU1, XU4, XU13, XU14 
Digital Inputs	
Lower, Raise and Trip Bias 24 VDC Field Powered Contacts	XU5, XU9, XU11 
System Powered from E1 (24 VDC)	
System Powered from E2 (24 VDC)	
Digital Outputs	
Emergency Manual 24 VDC Field Powered	XU5, XU9, XU11 
System Powered from E1 (24 VDC)	
System Powered from E2 (24 VDC)	 TP27196A

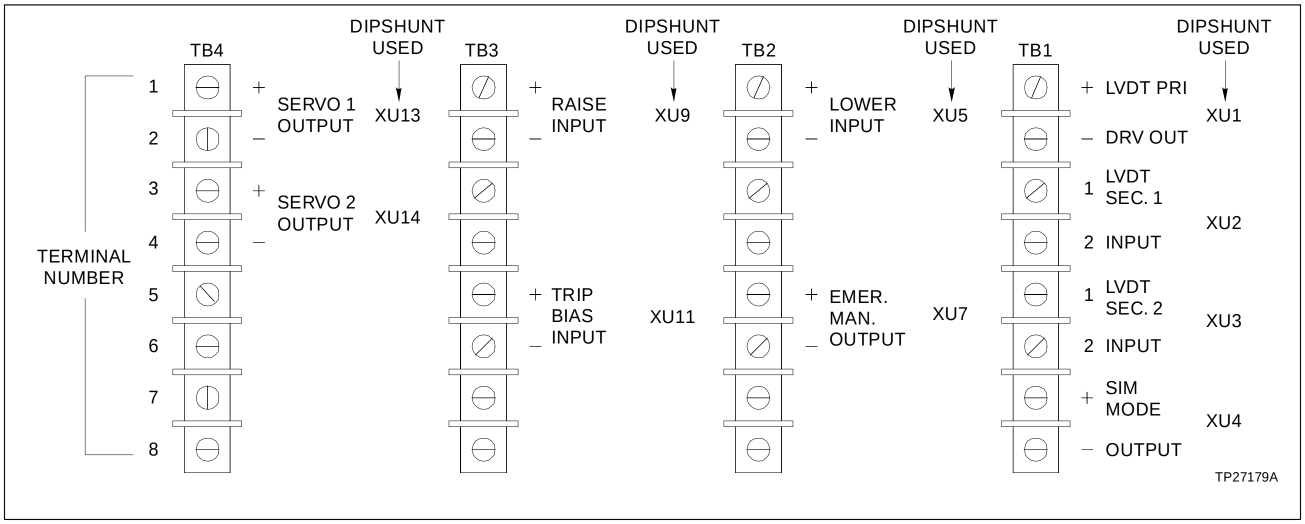


Figure B-2. NTDI01 Terminal Block Assignments for I/O Signals

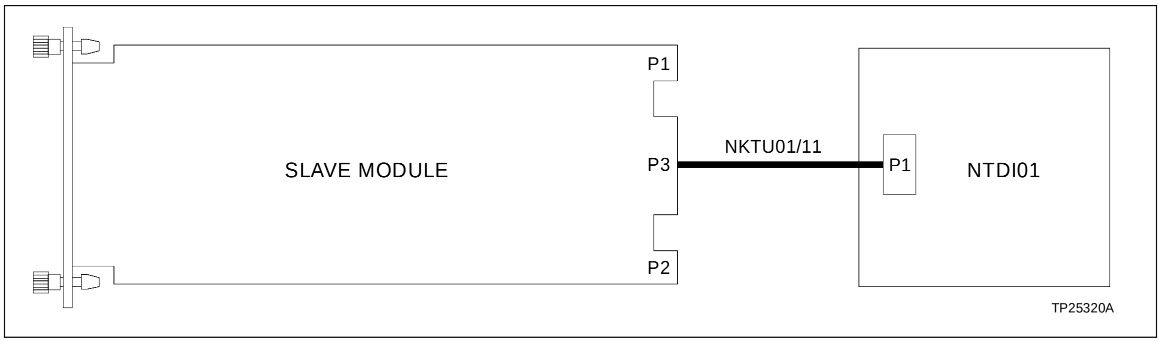


Figure B-3. HSS to NTDI01 Termination Cable Connection

APPENDIX C - DIGITAL INPUT TERMINATION MODULE (NIDI01)

INTRODUCTION

The IMHSS02 uses an NIDI01 termination module to terminate I/O signals. Jumpers on the termination module configure the I/O signals. The hydraulic servo slave (HSS) module provides one digital and four analog outputs, and three digital and two analog inputs for control of hydraulic actuators.

Figure C-1 shows the jumper settings and their location on the NIDI01 circuit board. As shown in Figure C-1, jumpers 1 through 9 remain intact (shorted), jumper 10 is open. Figure C-2 shows the terminal assignment and polarity for each of the I/O signals. Refer to this figure when connecting field wiring to the NIDI01. Figure C-3 shows how to connect the termination cable from the NIDI01 to the IMHSS02.

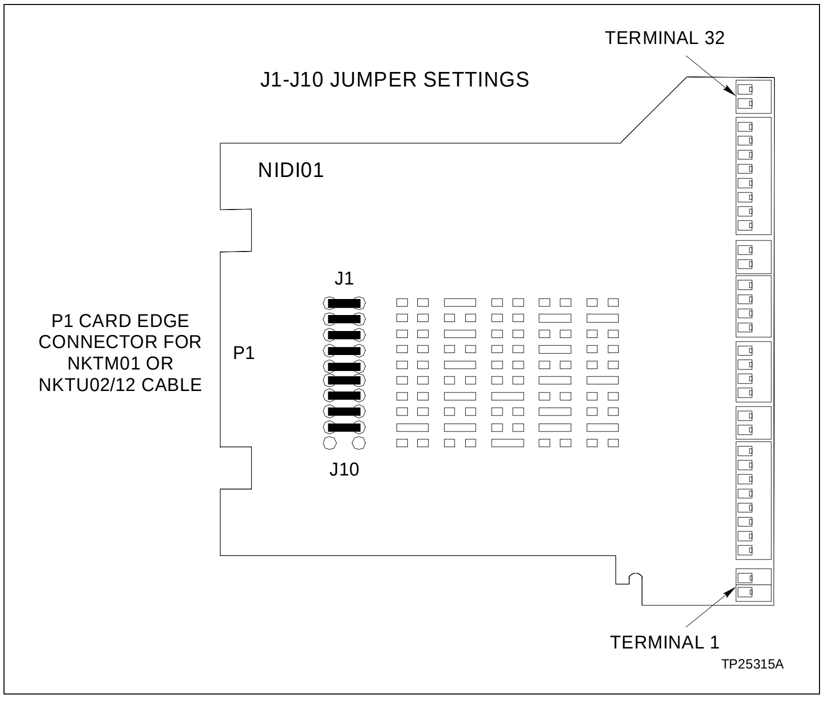


Figure C-1. HSS Jumper Settings and Location on the NIDI01

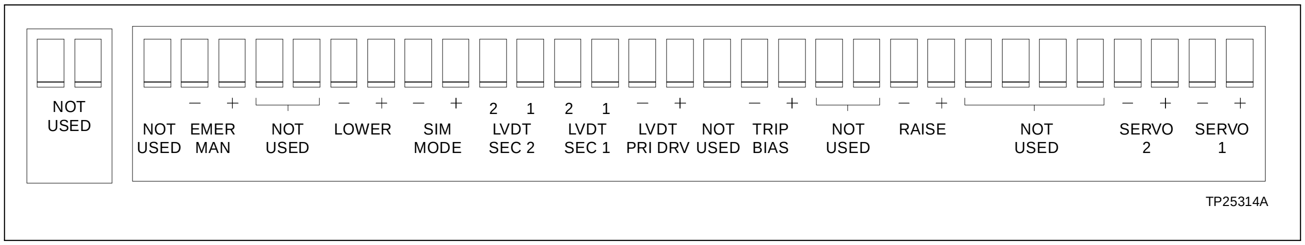


Figure C-2. I/O Signal Terminal Assignments for the HSS

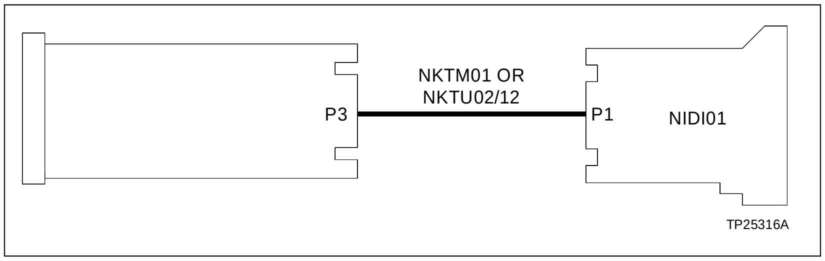


Figure C-3. HSS to NIDI01 Termination Cable Connection

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Index (continued)

Index (continued)

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