MOORE INDUSTRIES

INSTRUCTION MANUAL

Includes SPI

PPI

Pneumattic Integrator

Form 201-701-00B

August 1985

SECTION 1
GENERAL INFORMATION

1.0 SCOPE OF MANUAL

This manual contains operating and maintenance information on the Solid-state Pneumatic Integrator (SPI/PPI) system, manufactured by MOORE INDUSTRIES INCORPORATED, Sepulveda, California. The manual consists of following six sections:

Section 1. General Information, provides the physical and functional configuration for the unit. A model number explanation is also included.

Section 2. Calibration Procedures, provides information necessary for adjustment and calibration of the unit. This section contains a list of the tools necessary for adjusting the equipment. A test connection diagram is included.

Section 3. Installation and operation, this section contains mechanical and electrical installation instructions, which include recommended wiring practices and electrical connections for the unit.

Section 4. Theory of operation, describes the circuit operating principles based on a simplified schematic diagram.

Section 5. Maintenance and Troubleshooting, gives step-by-step procedures for maintaining and troubleshooting equipment.

Section 6. Unit Documentation, contains engineering drawings, specification data sheet, and installation and outline drawings.

The terms **NOTE, CAUTION,** and **WARNING,** have specific meanings.

A **NOTE** provides additional information that makes it easier to perform a particular task. Failure to follow a note may result in some inconvenience or needless expense, but the unit will not be damaged, nor is the Instrument Technician likely to be injured.

A **CAUTION** stresses important details to follow when making electrical connections or cleaning PC board contacts. Failure to follow a note may damage the unit, void the Moore Industries warranty, or cause minor physical injury to the Instrument Technician.

A **WARNING** provides vital safety information that must not be ignored. Warnings deal with proper grounding of equipment, use of solvents, etc. Ignoring warnings may damage the unit and risk personal injury or even death to the Instrument Technician.

1.1 DESCRIPTION

The SPI/PPI system converts a pneumatic input signal to either a linear or an optional square-root function for display on the self-contained 6-digit counter. The system consists of a PIT, a LIT or SIT, and the 6-digit counter.

1.2 SPECIFICATIONS

Refer to Section 6.0 for complete specifications for the SPI/PPI. This specification sheet provides information on input, output, performance capability, housing, and electrical options.

1.3 MODEL NUMBER EXPLANATION AND USE

MOORE INDUSTRIES model numbers identify the instrument type, function characteristics, operating parameters, and any options ordered. If the documentation is missing, the model number can be used to obtain technical information on the unit. See Table 1-1.

1.4 SERIAL NUMBER USE AND LOCATION

MOORE INDUSTRIES keeps a complete history on each unit sold. This historical information is keyed to the serial number. If service is required on a unit, it is necessary to provide the factory with the serial number as well as the model number. This identification is usually located on the bottom cover support. The cover must be removed in order to see the serial number of the unit.

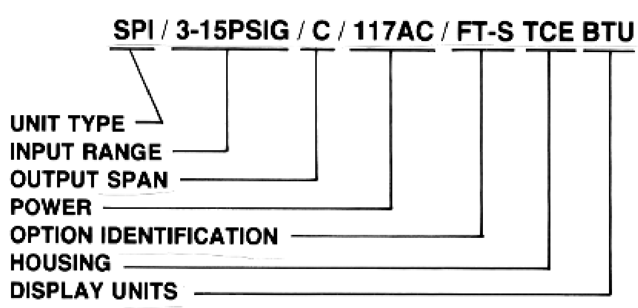


TABLE 1-1 SAMPLE MODEL NUMBER

2.0 CALIBRATION PROCEDURES

This section provides information for unit adjustment and calibration. Each unit is adjusted and checked for proper performance at the factory before shipping. However, input and output values for each unit should be checked on site by the user before the equipment is placed into service. See paragraph 1.3 and the Specification Data Sheet in Section 6.0 for minimum and maximum inputs and outputs.

2.1 GENERAL INFORMATION

After a Solid-state Pneumatic Integrator (SPI/PPI) unit is unpacked, general operating level checks are recommended using the calibration procedures in this section. If units are ordered with factory calibration (–FC) option, an exact calibration is performed at the factory and red caps are put over the controls. Adjustments should not be made in the field to the units with red caps unless a new range of input or output signals is desired.

2.2 CONTROL DESCRIPTION AND LOCATION

ZERO and SPAN adjustments are 22-turn potentiometers adjustable with a blade screwdriver.

CAUTION

SCREWDRIVER BLADE MUST NOT BE MORE THAN 0.1 INCH (2.54 MM) WIDE. USE OF A WIDE BLADE MAY PERMANENTLY DAMAGE THE POTENTIOMETER MOUNTING

2.3 TEST EQUIPMENT AND TOOLS REQUIRED

Test equipment and tools required for calibration of the SPI/PPI are described in Table 2-1; they are not supplied and must be provided by the customer at the installation or test site.

2.4 TEST EQUIPMENT SET-UP

The test equipment set-up required to calibrate an SPI/PPI unit is shown in Figure 2-1.

TABLE 2-1
TEST EQUIPMENT AND TOOLS REQUIRED

Equipment or Tool	Characteristic	Purpose
Screwdriver (blade)	Blade not wider than 2.54 mm (0.1 inch)	Front panel control adjustment
Instrument Air Supply	3-15, 3-27 psig or 6-30 psig	Simulates pressure input
DC Milliammeter	Must be accurate to within ±0.05% or better	Output signal monitoring
DC Oscilloscope	Tectronix T935 or equivalent	Input signal monitoring during calibration with electronic counter output monitoring
Electronic Counter	HP Model 523D or equivalent	Output signal monitoring

2.5 CALIBRATION

SPI/PPI units are calibrated and checked for proper performance at the factory before they are shipped. However, unless calibration was requested to a specific set of input/output values, the performance of the unit should be checked by the user before the module is placed in service.

Calibration consists of simulating the operative signal input and adjusting the unit to obtain the specified output.

> **NOTE**
> ADJUSTMENTS SHOULD NOT BE MADE IN THE FIELD TO UNITS THAT ARE CALIBRATED AT THE FACTORY TO CUSTOMER'S SPECIFICATIONS. UNITS CALIBRATED IN THIS MANNER HAVE PROTECTIVE RED CAPS OVER THE SPAN AND ZERO POTENTIOMETERS.

An adjustable signal source and input monitoring device are required for calibration. An electronic counter to determine output pulse rate and a dc oscilloscope to accurately observe the zero adjustment are also required.

2.5.1 CALIBRATION OF UNIT WITHOUT −RR OPTION

To facilitate adjustment and calibration of the SPI/PPI, three test points are brought out to the external terminal board. They are identified as CAL1, CAL2, and CAL3, and are referenced to the −IN terminal.

CAL1 is monitored with the dc volt meter while making the initial ZERO potentiometer setting to obtain approximately +7mV at this terminal with a 0% output signal. (This biases the analog signal input to the first integrator at the zero level to compensate for the live zero input.)

CAL2 brings out the ±10V pulse count signal ahead of the divider which scales the pulse rate to appropriate engineering units for the output signal. (Note: Monitor the events counter for internal display. This gives a faster and more accurate test reading than monitoring the output directly.)

CAL3 provides access to the count dropout comparator (±10V binary signal). This facilitates monitoring the count dropout potentiometer when adjusting for a specific input level.

Full Scale Output Count Rate: Connect the SPI/PPI and test equipment as shown in Figure 2-1. The Full Scale Output Count is defined by the user (refer to your SPI/PPI model number and paragraph for further explanation). The appropriate range is selected by moving the range jumper as indicated in Table 2-2.

Initial Setting of the ZERO Potentiometer: Connect the electronic counter between CAL2 and the −IN terminal. Set the input signal to 100%. Using the appropriate scale factor from Table 2-3, determine the equivalent full scale count at CAL2 in counts/second. Divide this number into one (1) to get the correct period count in milliseconds. Set the counter for "period" and adjust the SPAN potentiometer until the counter displays the correct period as calculated above.

Final Setting of the ZERO and SPAN Potentiometers: Set the input at 25% of full SPAN and calculate the correct interval as: $1/\sqrt{.25}$ x full scale counts per second. Since $\sqrt{.25} = .5$, the output = 1/.5 x full scale counter per second. Readjust the ZERO potentiometer to generate this interval on the counter display. Repeat the fullscale and 25% of full scale input settings to the ZERO and SPAN potentiometers until no further adjustments are necessary.

Input and Output Tracking: Input and output tracking can be verified at any desired intermediate point by calculating the following relationship:

output count rate = 100% output count rate x % input

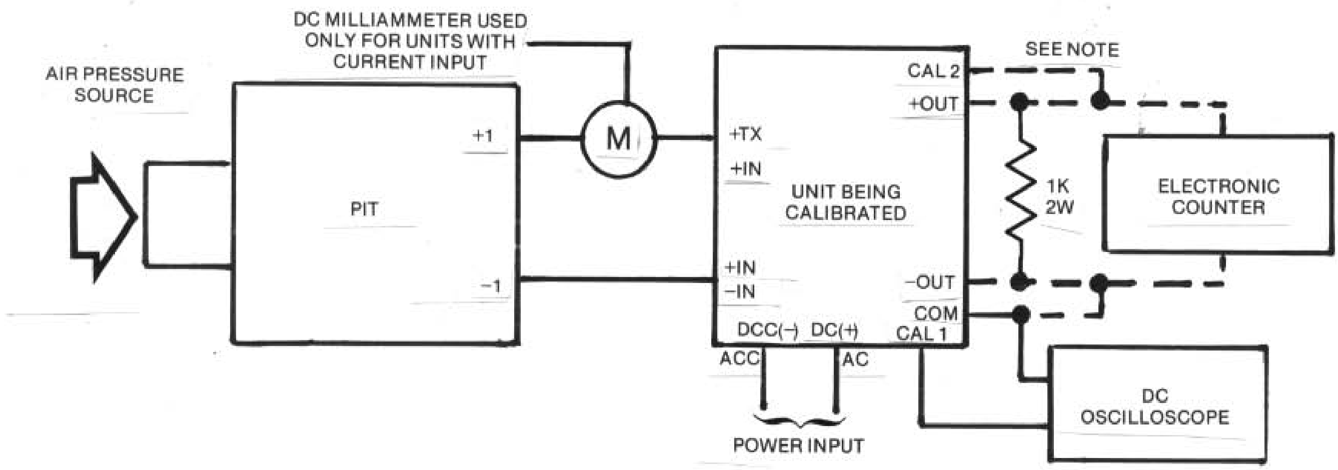
output period = 1/(100% output count rate) x % input

> **NOTE**
> MULTIPLY THE READING BY THE APPROPRIATE FACTOR IN TABLE 2-3 BEFORE CONVERTING TO THE COUNT RATE AT THE OUTPUT. THE CALCULATED COUNT RATES SHOULD FALL WITHIN THE PARAMETERS IN TABLE 2-4.

The output should follow the calculated values within 0.1% of the full scale.

While monitoring the CAL3 terminal, decrease the input signal amplitude until the unit stops counting (this is indicated by the CAL3 voltage dropping to −10Vdc). Observe the level at which this occurs. Adjust the input signal to the desired count dropout level and adjust the count dropout potentionmeter to obtain −10Vdc at this level.

After all the preceding steps have been successfully completed, remove the input signal source and turn off the power to the unit.



NOTES:
1. On unit with full scale output rante A through F, connect counter to CAL 2 and COM terminals; connect counter to ±OUT terminals for full scale output ranges G through J.

FIGURE 2-1 TEST EQUIPMENT SET-UP

OUTPUT PULSE RATE RANGES		STD CIRCUIT MODIFICATIONS (PC3) *								
	J300	J301	J302	J303	J304	J305	J306	J307	J308	J309
A1									USED	
A								USED		
B							USED			
C						USED				
D					USED					
E				USED						
F			USED							
G		USED								
H	USED									
J										USED

BLANK SPACES: JUMPERS NOT USED OR COMPONENTS UNAFFECTED.

*Jumpers located on PC2 in Plug-in version

TABLE 2-2. CIRCUIT MODIFICATIONS TO CHANGE OUTPUT PULSE RATE RANGES

OUTPUT RANGE	TO OBTAIN OUTPUT COUNT RATE, DIVIDE COUNT RATE AT CAL 2 BY:
A1	512
A	256
B	128
C	64
D	32
E	16
F	8
G	4
H	2
J	1

TABLE 2-3. OUTPUT FULL SCALE COUNT RATES VS. COUNT RATES AT CAL2 TERMINAL

	Counts/Hr		Counts/Min		Counts/Sec		Period/Count	
Range	Min	Max	Min	Max	Min	Max	Min	Max
A1	50	100	0.83	1.66	0.01388	0.02777	36.0	72.0 sec.
A	100	200	1.66	3.33	0.02777	0.05555	18.0	36.0 sec.
B	200	400	3.33	6.66	0.05555	0.01111	9.0	18.0 sec.
C	400	800	6.66	13.33	0.1111	0.2222	4.5	9.0 sec.
D	800	1,600	13.33	26.66	0.2222	0.4444	2.25	4.5 sec.
E	1,600	3,200	26.66	53.33	0.4444	0.8888	1.125	2.25 sec.
F	3,200	6,400	53.33	106.66	0.8888	1.7777	0.5625	1.125 sec.
G	6,400	12,800	106.66	213.33	1.7777	3.5555	281.25	562.5 ms.
H	12,800	25,600	213.33	426.66	3.5555	7.1111	140.625	281.25 ms.
J	25,600	51,200	426.66	853.33	7.1111	14.2222	70.3125	140.625 ms.

TABLE 2-4. FULL SCALE COUNT RATES AND COUNTER PERIOD FOR VARIOUS RANGES

2.5.2 CALIBRATION OF UNIT WITH −RR OPTION

To calibrate an SPI/PPI that includes the −RR option, connect the test set-up as shown in Figure 2-1 and perform the calibration procedures from paragraph 2.5.1.

2.5.3 CALCULATING CALIBRATION VALUES

To calculate correct calibration values, use the following example.

EXAMPLE

The input span is 4-20mA (0%-100%) and the output is 0-7922 counts/hour. Proceed as follows:

1. Determine the signal period (frequency) at +OUT in seconds/counts.

   A. $\text{counts/min} = \frac{\text{counts/hr}}{60 \text{ mins}} = \frac{7922}{60} = 132.2$

   B. $\text{counts/sec} = \frac{\text{counts/min}}{60 \text{ secs}} = \frac{132.2}{60} = 2.200$

   C. $\text{sec/counts} = \frac{1}{\text{counts/sec}} = \frac{1}{2.2} = .45443$

2. Determine the signal period (frequency) at CAL2 in milliseconds/counts.

   A. Refer to Table 2-4 for range at 7922 counts/hour. The range is G.

   B. Refer to Table 2-3 for the divisor for range G. The divisor is 4.

   C. $\text{secs/counts} = \frac{\text{secs/count at +OUT}}{4} = \frac{.45443}{4} = .11361$

   D. milliseconds/count = .11361 x 1000 = 113.61

3. Refer to Table 2-2 and install jumper in G range and adjust the count dropout to minimum for CCDX options; for other options, turn the count dropout potentiometer @ the maximum amount counter-clockwise.

4. Turn on the power, connect an oscilloscope or digital volt meter (DVM) between CAL1 and −IN, and set the ZERO potentiometer for +7mV, with 0% at −IN.

5. Connect a counter/timer instrument between CAL2 and −IN.

6. Set the input at 100% (20mA) and set the SPAN potentiometer for 113.61 milliseconds (calculated in step 2).

7. Set the input at 25% (8mA) and set the ZERO potentiometer for 227.22 milliseconds (at CAL2 the count period will be twice as much at 25% input as at 100% input;thus, 2 x 113.61 = 227.22).

8. Repeat steps 6 and 7 until no further adjustment is needed.

To ensure that calibration is accurate over all, also set the inputs between CAL2 and −IN at 50% and 75%. At 50% input, the rate is 160.668 milliseconds; at 75% input, the rate is 131.185 milliseconds.

2.6 OUTPUT PULSE RATE RANGE

The output pulse rate can be changed in the field by modifying the jumper connections on the pulse rate circuit board (PC3) and components on both the pulse rate circuit board and the main board (PC1). See Table 2-3.

2.6.1 RATE METER SPAN ADJUSTMENT

Systems equipped with a rate meter have a SPAN adjustment potentiometer and associated circuits located on a PC board mounted to the terminals of the meter. To adjust, apply 100% input signal to the system and adjust the potentiometer for a full scale reading.

3.0 INSTALLLATION AND OPERATION

3.1 MECHANICAL INSTALLATION

The SPI/PPI is available in several physical configurations. Installation details can be found on the Outline and Installation drawing contained in Section 6.0 Observe any special procedures and precautions given with the illustraiton.

Although the units are designed to operate in free air at quite high ambient temperatures, it is advisable to mount the unit on a surface that has adequate ventilation.

3.2 ELECTRICAL CONNECTIONS

Special wire or cable is not required for signal connections to the unit. To avoid transients and stray pick-ups, it is recommended that twisted conductors be used where they run close to other services (such as power wiring). Electircal connections fall into two major categories: connection to all standard units with terminal blocks, and connections to plug-in units.

Standard Units: Standard units with terminal strips or terminal blocks have terminals supplied with 6-32 screws long enough to accommodate three spade lug connectors. Dress all wiring to and from the terminals along the connecting edge of the unit. Spade lug connectors are recommended for all wire terminations. Refer to Table 3-1 for terminal nomenclature.

NEMA Enclosures: Units mounted in NEMA boxes are terminal strip units. Oil tight (−OT) or water tight (−WT) options have conduit hole fittings for conduit access.

Corrosion-proof (TCE) Enclosures: Corrosion-proof (TCE) enclosures are polyester resin material. Ground continuity may be obtained in two different ways. If a metal panel is used, ground between the metal conduit locknut and the panel at enclosure entry and exit. If the enclosure is used without the back, panel, use a jumper between the conduit entry and exit to maintain ground continuity. Remove screw-on plastic cover to access terminal strips.

Panel Mounted (PME) Units: Panel mounted unit electrical connections are made to terminals on the rear connector. Refer to Table 3-1 for terminal nomenclature.

3.2.1 POWER CONNECTIONS

SPI/PPI units operate from either a dc or an ac power source. Refer to your model number on the unit and paragraph 1.3 to determine the type of power required.

DC Powered Units: The DC terminal is connected to the + (positive) side of the power source; the DCC terminal is connected to the − (negative) side. The dc source should be regulated to within ±10% of the nominal voltage and should be capable of delivering 5 watts.

AC Powered Units: The AC terminal is connected to the ungrounded or "hot" side of the power source; the ACC terminal is connected to Common or neutral. The GND terminal is the mechanical case connection. These units require 117Vac, ±10%, 50/60Hz at 5Vac of nominal power or 220/240Vac optionally.

Options	Terminal Positions (See Note)											
	1	2	3	4	5	6	7	8	9	10	11	12
NONE	CAL 2	COM	CAL 1	DCC	DC	GND			+IN	−IN	+OUT	−OUT
AC	CAL 2	COM	CAL 1	ACC	AC	GND			+IN	−IN	+OUT	−OUT
SC (input) (Note 2)												
TX							+TX					

NOTE: Legend

DC	+DC Power Input	GND	Chassis Ground
DCC	−DC Power Input	AC	AC Power Input
		ACC	AC Power Return

**TABLE 3-1.
TERMINAL NOMENCLATURE**

4.0 THEORY OF OPERTION

This section describes the operation of Model SPI/PPI. The functional description is based on the unit block diagram, Figure 4-1.

4.1 PIT MODULE CIRCUITS FUNCTIONAL DESCRIPTION

Air pressure is converted to an electronic signal by the PIT transducer. The signal is amplified, and the output current provides the input signal for the SIT/LIT module.

4.1.1 POWER SUPPLY CIRCUIT DESCRIPTION

The power supply circuit provides two constant current sources. One current source excites the transducer, while the other drives a zener diode which provides a constant voltage to the zero bridge and the output amplifier.

4.1.2 ZERO REFERENCE CIRCUIT DESCRIPTION

The zero rerference circuit is a resistor bridge that generates a reference signal for the output amplifier. The reference signal is adjustable by the ZERO control.

4.1.3 OUTPUT CIRCUIT DESCRIPTION

The output circuit consists of a differential amplifier and output buffers. The differential amplifier compares the output of the transducer with the output of the zero reference circuit. The output amplifier drives the buffers that provide the controlled current output for the return line. The current output is proportional to the signal level at the input of the output circuits. The buffers also invert a signal in the amplifier feedback loop.

4.2 SIT MODULE

4.2.1 FUNCTIONAL DESCRIPTION

The input signal for the Model SIT is first converted to a dc voltage proportional to the amplitude of the applied input signal. The voltage is then applied to a linear frequency converter, which produces output pulses at a rate linearly proportional to the amplitude of the input signal.

4.2.2 POWER SUPPLY CIRCUIT DESCRIPTION

Units are usually supplied for use with either an ac or dc power input. On units for use with an ac power input, the power supply typically develops a 24-volt dc output that is applied to the input of the power inverter. On units intended for a dc power input, the power is applied directly to the input of the power inverter, with diode proteciton to prevent damage to the power inverter components if the dc power input is accidentally connected with reversed polarity.

4.2.3 POWER INVERTER CIRCUIT DESCRIPTION

The power inverter produces a number of outputs from the dc applied to its input. Two separate square-wave outputs at approximately 3KHz are developed. A set of regulated positive and negative dc outputs are reduced and used as operating voltages for the unit. The inverter also produces a positive dc output as the operting voltage for the power amplifier. A 400 milliamp fuse (−FU option) placed in series with the +DC input protects the unit from damage where dc voltage may fluctuate enough to cause excessive current drain on the unit.

4.2.4 RECTIFIER AND REGULATOR CIRCUITS

The rectifiers accept the outputs from either the ac power supply or the power inverter and produce unregulated positive and negative voltages (of equal value with respect to ground). Two regulators reduce these voltages to the required operating values and regulate them against changes with load or line or voltage variations. Another rectifier produces a higher unregulated output used as operating voltages for the −TX option.

4.2.5 INPUT NETWORK AND ZERO ADJUST CIRCUITS

The input signal is provided with the proper termination by the input network and is combined with the voltage from the zero adjust circuit. The zero adjust circuit adds an adjustable positive voltage to cancel the live zero of the basic input signal. With a low value of input signal applied, the zero adjust circuit is adjusted so the voltage added to the applied input signal results in a zero count rate. Zero adjust voltage is provided to the inverting input amplifier while the incoming signal is connected directly to the non-inverting input to the amplifier.

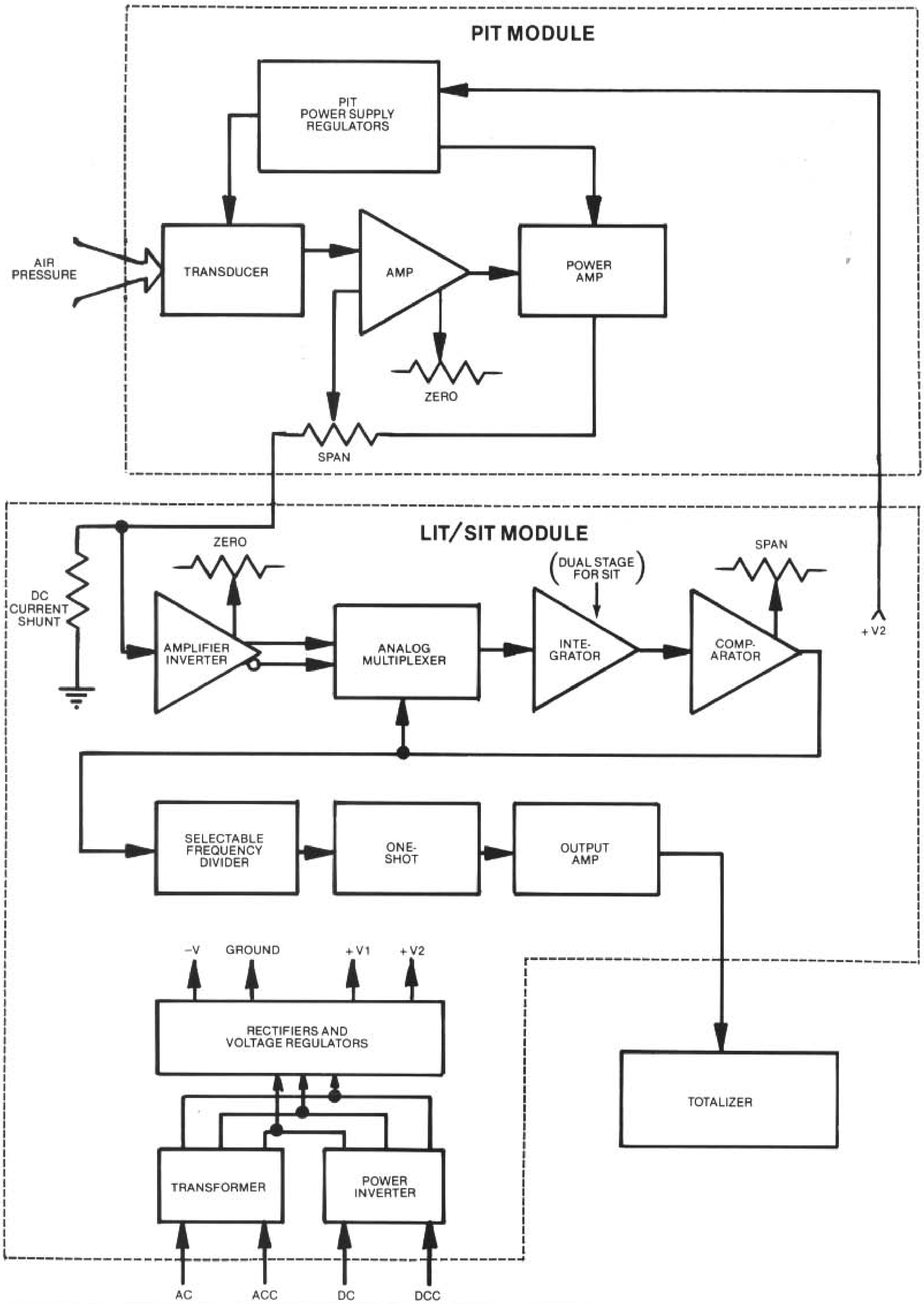


FIGURE 4-1.
SYSTEM BLOCK DIAGRAM

4.2.6 INPUT AMPLIFIER CIRCUIT

The input amplifier increases the level of the composite input signal. No inversion takes place in this amplifier. The output of the amplifier drives the next stage, which is an inverter. The output is also applied to one input of the coupling network that supplies the signal to the integrator. High stability of the amplifier is achieved through the use of feedback.

4.2.7 INVERTER CIRCUIT

The output from the input amplifier is applied to the inverter, which has a gain of unity and produces and output with a polarity opposite to that of the input applied to this stage. The inverter provides one of the two signals of opposite polarity required by the coupling network that applies a signal to the integrator (the other signal to the network is provided by the input amplifier). Feedback is used in the inverter to achieve high stability and also to establish the gain.

4.2.8 DOUBLE INTEGRATOR–COMPARATOR CIRCUITS

The double integrator-comparator combination produces, as the comparator output, pulses at a rate proportional to the amplitude of the input signal.

4.2.9 FREQUENCY DIVIDER CIRCUIT

The frequency divider receives pulses at the basic pulse rate if the desired full scale pulse-rate output from the unit is lower than range J (25,600 to 51,200 counts per hour). The frequency divider then produces one output pulse for every N pulses applied to its input, where N is the number by which the basic pulse rate must be divided to obtain the desired output pulse from the unit.

4.2.10 ONE-SHOT GENERATOR CIRCUIT

Since the duration of the pulses produced by the comparator varies with the pulse rate, a stage is used to convert these pulses to an output of constant duration regardless of pulse rate. The one-shot generator accepts the basic or divided pulses and produces a 30 millisecond output pulse for each pulse received.

4.2.11 POWER AMPLIFIER CIRCUIT

The one-shot generator produces output at a low power level. To drive a counter or a relay, the power of these pulses must be amplified. A two-stage power amplifier produces output pulses with enough power to drive either an external counter or the optional internal relay.

4.3 LIT MODULE

4.3.1 FUNCTIONAL DESCRIPTION

The input signal of the Model LIT is first converted to a dc voltage proportional to the amplitude of the applied input signal. The voltage is then applied to a linear frequency converter, which produces output pulses at a rate linearly proportional to the amplitude of the input signal.

The output pulses from the unit can drive an external totalizer (counter) directly, or an optional relay may be used for this purpose. The zero dropout circuit (eliminates counting when the signal is below 0.5 to 1% above the minimum input) prevents noise, zero offset errors, etc. from producing spurious counts with a signal level near 0%. A potentiometer is provided to adjust the exact point of dropout.

4.3.2 POWER SUPPLY CIRCUIT DESCRIPTION

Units are usually supplied for use with either an ac or dc power input. On units for use with an ac power input, the power supply typically develops a 24-volt dc output that is applied to the input of the power inverter. On units intended for a dc power input, the power is applied directly to the input of the power inverter, with diode protection to prevent damage to the power inverter components if the dc power input is accidentally connected with reversed polarity.

4.3.3 POWER INVERTER CIRCUIT DESCRIPTION

The power inverter produces a number of outputs from the dc applied to its input. Two separate square-wave outputs at approximately 3KHz are developed. A set of regulated positive and negative dc outputs are reduced and used as operating voltages for the unit. The inverter also produces a positive dc output as the operating voltage for the power amplifier. A 400 milliamp fuse (−FU option) placed in series with the +dc input protects the unit from damage where dc voltage may fluctuate enough to cause excessive current drain on the unit.

4.3.4 RECTIFIER AND REGULATOR CIRUITS

The rectifiers accept the outputs from either the ac power supply or the power inverter and produce unregulated positive and negative voltages (of equal value with respect to ground). Two regulators reduce these voltages to the required operating values and regulate them against changes with load or line voltage variations. Another rectifier produces a higher unregulated output that is used as operating for the −TX option.

4.3.5 INPUT NETWORK AND ZERO ADJUST CIRCUITS

The input signal is provided with the proper terminations by the input network and is combined with the voltage from the zero adjust circuit. The zero adjust circuit adds an adjustable positive voltage to cancel the live zero of the basic input signal. With a low value of input signal applied, the zero adjust circuit is adjusted so the voltage added to the applied input signal results in a zero count rate. Zero adjust voltage is provided to the inverting input amplifier while the incoming signal is connected directly to the non-inverting input to the amplifier.

4.3.6 INPUT AMPLIFIER CIRCUIT

The input amplifier increases the level of the composite input signal. No inversion takes place in this amplifier. The output of the amplifier drives the next stage, which is an inverter. The output is also applied to one input of the coupling network that supplies the signal to to integrator. High stability of the amplifier is achieved through the use of feedback.

4.3.7 INVERTER CIRCUIT

The output from the input amplifier is applied to the inverter, which has a gain of unity and produces an output with a polarity opposite to that of the input applied to this stage. The inverter provides one of the two signals of opposite polarity required by the coupling network that applies a signal to the integrator (the other signal to the network is provided by the input amplifier). Feedback is used in the inverter to achieve high stability and also to establish the gain.

4.3.8 INTEGRATOR-COMPARATOR CIRCUITS

The integrator-comparator combination produces, as the comparator output, pulses at a rate proportional to the amplitude of the input signal.

4.3.9 ONE-SHOT GENERATOR CIRCUIT

Since the duration of the pulses produced by the comparator varies with the pulse rate, a stage is used to convert these pulses to an output of constant duration regardless of pulse rate. The one-shot generator accepts the basic or divided pulses and produces a 35 millisecond output pulse for each pulse received.

4.3.10 POWER AMPLIFIER CIRCUIT

The one-shot generator produces output at a low power level. To drive a counter or a relay, the power of these pulses must be amplified. A two-stage power amplifier produces output pulses with enough power to drive either an external counter or the option internal relay.

5.0 MAINTENANCE AND TROUBLESHOOTING

All units found to be performing below specifications should be returned to the factory for service in accordance with the instructions found on the inside back cover of this manual.

In an emergency, the user may contact the Customer Service department for verbal assistance in diagnosing and repairing a totalizer problem.

5.1 MAINTENANCE

The design of the SPI/PPI limits maintenance primarily to keeping the input and output terminals and conductors clean and tight. A thorough cleaning of terminal blocks for standard units and contacts of the plug-in modules requires complete disassembly and should only be done at the factory. It is recommended that the user check the terminations every six months of service to verify that they are secure and free of oxidation.

5.2 TROUBLESHOOTING

If a problem is suspected with the SPI/PPI, review the following procedures:

1. Verify that all electrical connections are clean and tight.
2. Verify that the measuring instrument used for input voltage or current is of the proper range and accuracy.
3. Verify that the output circuit is electrically isolated from the input circuit.

If the problem still exists, the unit might be defective and should be returned to the factory for repair in accordance with the instructions found on the inside back cover of this manual.

RETURN PROCEDURES

To return equipment to Moore Industries for repair, follow these four steps:

1. Call Moore Industries and request a Returned Material Authorization (RMA) number.

   Warranty Repair –
   If you are unsure if your unit is still under warranty, we can use the unit's serial number to verify the warranty status for you over the phone. Be sure to include the RMA number on all documentation.

   Non-Warranty Repair –
   If your unit is out of warranty, be prepared to give us a Purchase Order number when you call. In most cases, we will be able to quote you the repair costs at that time. The repair price you are quoted will be a "Not To Exceed" price, which means that the actual repair costs may be less than the quote. Be sure to include the RMA number on all documentation.

2. Provide us with the following documentation:
   a) A note listing the symptoms that indicate the unit needs repair
   b) Complete shipping information for return of the equipment after repair
   c) The name and phone number of the person to contact if questions arise at the factory

3. Use sufficient packing material and carefully pack the equipment in a sturdy shipping container.

4. Ship the equipment to the Moore Industries location nearest you.

The returned equipment will be inspected and tested at the factory. A Moore Industries representative will contact the person designated on your documentation if more information is needed. The repaired equipment, or its replacement, will be returned to you in accordance with the shipping instructions furnished in your documentation.

WARRANTY DISCLAIMER

THE COMPANY MAKES NO EXPRESS, IMPLIED OR STATUTORY WARRANTIES (INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE) WITH RESPECT TO ANY GOODS OR SERVICES SOLD BY THE COMPANY. THE COMPANY DISCLAIMS ALL WARRANTIES ARISING FROM ANY COURSE OF DEALING OR TRADE USAGE, AND ANY BUYER OF GOODS OR SERVICES FROM THE COMPANY ACKNOWLEDGES THAT THERE ARE NO WARRANTIES IMPLIED BY CUSTOM OR USAGE IN THE TRADE OF THE BUYER AND OF THE COMPANY, AND THAT ANY PRIOR DEALINGS OF THE BUYER WITH THE COMPANY DO NOT IMPLY THAT THE COMPANY WARRANTS THE GOODS OR SERVICES IN ANY WAY.

ANY BUYER OF GOODS OR SERVICES FROM THE COMPANY AGREES WITH THE COMPANY THAT THE SOLE AND EXCLUSIVE REMEDIES FOR BREACH OF ANY WARRANTY CONCERNING THE GOODS OR SERVICES SHALL BE FOR THE COMPANY, AT ITS OPTION, TO REPAIR OR REPLACE THE GOODS OR SERVICES OR REFUND THE PURCHASE PRICE. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY CONSEQUENTIAL OR INCIDENTAL DAMAGES EVEN IF THE COMPANY FAILS IN ANY ATTEMPT TO REMEDY DEFECTS IN THE GOODS OR SERVICES , BUT IN SUCH CASE THE BUYER SHALL BE ENTITLED TO NO MORE THAN A REFUND OF ALL MONIES PAID TO THE COMPANY BY THE BUYER FOR PURCHASE OF THE GOODS OR SERVICES.

ANY CAUSE OF ACTION FOR BREACH OF ANY WARRANTY BY THE COMPANY SHALL BE BARRED UNLESS THE COMPANY RECEIVES FROM THE BUYER A WRITTEN NOTICE OF THE ALLEGED DEFECT OR BREACH WITHIN TEN DAYS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH, AND NO ACTION FOR THE BREACH OF ANY WARRANTY SHALL BE COMMENCED BY THE BUYER ANY LATER THAN TWELVE MONTHS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH.

RETURN POLICY

For a period of thirty-six (36) months from the date of shipment, and under normal conditions of use and service, Moore Industries ("The Company") will at its option replace, repair or refund the purchase price for any of its manufactured products found, upon return to the Company (transportation charges prepaid and otherwise in accordance with the return procedures established by The Company), to be defective in material or workmanship. This policy extends to the original Buyer only and not to Buyer's customers or the users of Buyer's products, unless Buyer is an engineering contractor in which case the policy shall extend to Buyer's immediate customer only. This policy shall not apply if the product has been subject to alteration, misuse, accident, neglect or improper application, installation, or operation. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

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