FLOW TRANSMITTERS

AW GEAR METERS

ELECTRONICS FOR INSTRUMENTATION

EMO-1005

Flow Computer

Operation Manual

Rev. 1a

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INTRODUCTION

The **EMO-1005** is a multi channel indicating, computing and signal processing system, applicable in single channel use and expandable to systems with as many as 250 independently operating channels. All its functions can be programmed through the programming keyboard in the front panel or optionally, by a host computer through a RS 422 (RS 232 option) serial port.

There are 5 selectable modes of operation (see page 19); the most popular are either **MONITOR** or **PID** (closed loop). In any mode both instantaneous flow rate and batch totalizing can be displayed simultaneously.

The main housing is equipped to hold four channel cards, the display board, the programming keyboard, the communication port and the power supply.

The display is a 16 character, two line alphanumeric Super-Twist LCD with back-lighting for improved readability in non-daylight situations.

Before installation read HARDWARE HINTS (page 38)

Each channel can be programmed with the following information:

- Rate scale and engineering units
- Totalizer scaling and engineering units
- Rate limit settings (four)
- Totalizer limit settings (four)
- Analog Output Gain
- Analog Output Offset
- Sample amount
- Cut-off frequency
- Analog Input Gain
- Monitor or PI mode
- Linearizer setting (10 points with linear interpolation between points)

Display of rate ratio between any two of the channels can also be programmed.

Typical applications for the EMO-1005 unit:

- Rate and total indicator for flow meters, tachometers, parts counters, etc.

- Processing unit for batch operations.

- Closed loop controller for flow rate, speed, etc.

- In applications with non-linear transmitters
  (frequency output not directly proportional w/flow or speed).

- Operations requiring limit outputs.

- Computing and display unit for:

  Flow meters

  Pressure transducers

  Tachometers

  Inductive pick-ups

  Hall sensors

  Temperature sensors

  Encoders

  Pulse generators

  Etc.

The EMO-1005 is capable of displaying 28 different engineering units.
Example of some of these are:

* Impulses/Gallon	* Ounces/Minute	* Volt
* Impulses/Liter	* Gallons/Minute	* Ampere
* Impulses/Revolution	* CC/Minute	* RPM
* Revolutions/Minute	* Pound/Minute	* Hertz
* Centipoises	* Feet/Minute	* PSI

USING THE EMO-1005

FLO 7	TOT 5	SPC 9	CHA
A/B 4	5	RAO 6	LIM
A+B 1	A 2	B 3	KFR
0	DP .	ENT	KFA

The EMO-1005 Keyboard

The keyboard has membrane type switches. There is no "click" heard or felt when pressing a key. The press on the key must be very firm to activate the switch. This type of keyboard was selected to avoid the likelihood of accidental programming.

Programming should in most cases be done once in a "lifetime" on the EMO-1005, so an "user-friendly" keyboard is not really that necessary.

If frequent programming or changes in the programmed values or set-points is necessary, interfacing to a PC through the serial port will make the programming task more "user-friendly".

UNIT INITIALIZATION

When powering up the EMO-1005 unit, the following sequence will display system hardware and software information.

LINE 1	Ram Test		Ram test .....
LINE 2	Ram and no Bat	or	Ram and battery

Line one indicates the RAM memory is being tested. Line two indicates whether the RAM memory battery back-up is installed and operational.

The next display screen appears as follows:

LINE1	CH1=M/L CH2=R/
LINE 2	CH3=P/ CH4=OFF

where,

CH means channel
the channel number is indicated after the CH.
The letter after the "=" means:

M = Channel in question is in **Monitoring Mode**
P = Channel in question is in **PID Mode**
R = Channel in question is in **Complex Ratio Mode**
OFF = Channel is **not** installed or is **not** responding

After the "/", an "L" would indicate the Linearizer is active.
A blank would indicate the Linearizer to be OFF.
If the channel card is in the **Gun-On Mode, Transparent Mode** or **Closed Loop Control (CLC) Mode** the channel will initialize as a **P** in the above screen.

The next screen is the operating screen with the channel information - actual rate/total values and engineering units.

A sample of the screen if the unit receiving a frequency signal would appears as follows:

LINE 1	01:	500.00 Hz
LINE 2	01:	22245.0 Imp

QUICK START

The EMO-1005 has several default values programmed in at the factory. This means you can hook it up and test it out before any serious programming is necessary. The unit comes up in Monitor mode as a default. The default rate scaling is 100 and the engineering units is Hertz (Hz). This means that a 100 Hz signal input on pin 4 will be displayed as 100 Hz on line 1. And the totalizer will display impulses (Imp) on line 2. When a frequency is detected on either pin 3 or 4, the LED under the connector on the back panel will start to blink at a steady rate.

SCREEN MANIPULATION

When the EMO-1005 is turned on it always returns to the last screen displayed before the unit was turned off. The EMO-1005 screen is easy manipulated to show different information. To select a different channel, press CHA and then the channel number, (1, 2,..) The channel will be displayed in line 1. The former line 1 will scroll into the line 2 position. The information located in line 2 will scroll off the display. It should be noted that the channel located in line 1 will be the channel which is displayed when the status display mode is selected. Also, when line 1 is scrolled into line 2 it remains in the current display mode and the new line 1 will also be in that mode unless otherwise changed.

NOTE: If the unit has **10 or more channels**, channel selection is entered as: **CHA** and then channel number, **01, 02.**. **11** etc, and after channel number press **ENT**.

DISPLAY MODE SELECTION

There are four **display modes** on a standard EMO-1005: **Rate, Total, Peak Rate** and **Simple Ratio**. The Rate Mode displays the current frequency coming into the EMO-1005. The Total Mode displays the totalized amount of impulses received from the transducer or flowmeter. The Peak Rate will display the highest rate reached during current readings. The Simple Ratio Mode displays the ratio **between channel 1 and the channel currently on line 1**. To select a new display mode (Total/Rate or Ratio) just press one of the **TOT, FLO** or **RAO** keys. This operation will change **only line 1**, not line 2. The display mode can be changed as many times as needed.

RATE

FLO

To display the rate press the **FLO** key. The **Rate Mode** displays the current incoming frequency for the channel selected on line 1. The displayed frequency is initially displayed in Hz. But the display can be programmed to any of the 28 familiar engineering units. For further information see the Programming section, page 11.

The rate will be displayed in the following form:

LINE 1	01:XXXXX.XXXzzzz
LINE 2	

where,

01: is the channel number
XXXXX.XXX is the derived rate
zzzz is the selected engineering units
Sample engineering units: Hz, GPM, cc/m, li/m, etc.

The default unit is Hz.

TOTAL

TOT

To display the totalized amount press the **TOT** key. The **Total Mode** displays the current totalized incoming frequency on the channel selected in line 1. The totalized amount is initially displayed in impulses but the display can be programmed to any of 14 engineering units. For further information see the Programming section, page 12 .

The totalized amount will be displayed in the following form:

LINE 1	01:XXXXX.XXXzzzz
LINE 2	

where,

01: is the channel number
XXXXX.XXX is the derived totalized amount
zzzz is the selected engineering units
Sample engineering units: Imp, Gal, cc, REV, etc.

The default unit is Imp.

The Totalizer displayed on line one can be reset tozero by pressing the 0 (Zero) key on the keyboard.

SIMPLE RATIO

RAO

There are two ratios available on the EMO-1005: the **Simple Ratio** and the **Complex Ratio**. The Complex Ratio is a channel mode selection. This ratio changes the inputs and outputs on the channel designated to be in the Complex Ratio Mode. The Simple Ratio Mode however, does not affect anything on the unit but the display screen. When the **RAO** key is pressed, the channel being displayed on line 1 is changed to show a ratio of channel 1 **divided by the channel on line 1**.

The Simple Ratio is displayed in the following form:

LINE	CH1/CHxx ZZZ.ZZZ
LINE	

where,

CH1 means channel 1
/ means divided by
CH means channel
xx is the channel number on line 1
ZZZ.ZZZ is the ratio of this division

PEAK RATE

SPC

The Peak Rate Mode was added to give the user the ability to measure the highest rate a transducer reaches. This is very useful in applications where the rate is very inconsistent or unstable. By pressing the **SPC** key the unit will measure the incoming frequency and display the rate on line 1. Remember, the peak rate displayed will be that of the transducer plugged into the channel located on line 1 of the operatin screen. The Peak Rate will be reset to Zero when the Rate has been zero and starts again.

The peak rate will be displayed in the following form:

LINE 1	01/P XXXXX.XXzzz
LINE 2	

where,

01 is the channel number
/P means Peak Rate Mode
XXXXX.XX is the derived peak rate
zzz is the selected engineering units

STATUS DISPLAY MODE

Press the following key sequence:

CHA	->	DP	->	ENT	->	KFR

The status display will be displayed in the following form:

LINE 1	SDxx:XXXXPO/YYYY
LINE 2	AOzzzzAIyyyLOOIO

where,

xx: is the channel selected in line 1
XXXX is the input rate (frequency) in Hz
P indicates the mode: P = PID R = Complex Ratio
M = Monitor T = Transparent
G = Gun-On C = Closed Loop Control

O	indicates the Linearizer, O= Not active, L=Active
/	separator
YYYY	is the totalizer lowest 4 digits in impulses
AO	stands for Analog Output (1024 steps). 51.2 steps/mA.
zzzz	is the current Analog Output value in decimal (range is 0 - 1023)
AI	stands for Analog Input (256 steps). 12.8 steps/mA.
yyy	is the 8-bit analog converter value (000 - 255)
L	stands for Limits, O = Limit On, I = Limit Off
OOIO	
^..	Limit 1 Output (ON) (terminal 14)
^...	Limit 2 Output (OFF) (terminal 13)
^....	Limit 3 Output (ON) (terminal 12)
^.....	Limit 4 Output (ON) (terminal 11)
	(Terminal 15 is common for Limits)

The numbers for Digital input or Analog input/output are unscaled numbers. Rate Scaling or gain factors will have no effect on these numbers. By pressing the **CHA** key and then number 1, 2 or 3.... the status of other channels can be displayed. By doing this the status of the channel in line 1 of the normal operating screen will be displayed on line 1. To go out of the Status display and back to the normal operating display, press the **ENT** key. Check the status display first if there are any problems with any inputs or outputs.

The Limits in the Status Display have no validity in PID mode.

PROGRAMMING THE EMO-1005

To enter the programming mode press the following key sequence:

CHA	->	DP	->	ENT	->	KFA

Now the display will show:

LINE 1	PROGRAMMING
LINE 2	0 = NO 1 = YES

If this screen did not come up then try the key sequence once more (press slowly and firmly on the keys). If you would like to program press the 1 key; if not, press the 0 key. Pressing the 0 key returns the unit to the normal operating mode. If a 1 was pushed the following screen will appear:

LINE 1	ENTER CHANNEL
LINE 2	NUMBER=??

Enter the channel number that should be programmed and press the **ENT** key.
NOTE: Channel 1 = 01, 2 = 02 ....

Any mistakes made during programming in the next steps must be edited while at that screen. After leaving any display you must toggle through the remaining displays to return to the operating screen display. Then enter the programming mode again and toggle through until you get to the screen where you want to edit the entered value.

Before entering any new data in any of the programmable parameters, zero out the old data first. Then start to enter the new number. The numbers will be shifted to left as they are entered.

In the following lines the menu questions are listed in the order they appear while in programming mode:

	QUESTION:	ANSWER:	
Display 1	RATE SCALING ? 0 = NO and 1 = YES	0 or 1	ENTER
Display 2	TOTALIZER SCALE? 0 = NO and 1 = YES	0 or 1	ENTER
Display 3	LIMITS? (none=0) RATE=1 TOTAL=2	0, 1 or 2	ENTER
Display 4	ANALOG GAIN (KFA) CURRENT=00000167	Enter new KFA **ENT** alone is no change (167 is default)	
Display 5	OFFSET ANALOGOUT CURRENT=00000205	Enter new number **ENT** alone is no change (205 is default)	
Display 6	SAMPLE AMOUNT CURRENT=00000008	Enter new number **ENT** alone is no change (8 is default)	
Display 7	CUTOFF FREQ. CURRENT=00000050	Enter new number **ENT** alone is no change (50 is default)	
Display 8	ANALOG IN GAIN CURRENT=00000000	Enter new number **ENT** alone is no change (0 is default) (Only used in PID Mode)	

In the following sections, all of the previous displays will be explained in detail.

RATE SCALING - KFR (Display 1)

By answering with a 0 the scaling will be skipped.
By answering with a 1 the following display appears:

CURRENT KFR/UNIT
XXXXXXXX.X YYYY

where,

XXXXXXX.X is the current rate scaling
YYYY is the selected engineering units

The EMO-1005 is programmed, at the factory, to calculate the incoming frequency in Hertz (Hz). In order to make the EMO-1005 show a more convenient engineering unit, such as GPM, an appropriate scaling factor must be applied. This factor is called the **KFR** and is calculated by applying the K-factor of the transmitter that is being monitored. The K-factor is the number of impulses per engineering unit and is published by the transmitter manufacturer or established by a calibration test. (AW-Company provides a calibration test sheet with every flow meter).

For example a flowmeter could have a K-factor of 6304 imp/Gal or 329.22 imp/lit. A rpm pickup could be 34.66 imp/rev.

In order to calculate the KFR multiplier for the EMO-1005 apply the following formula.

$$\mathbf{KFR} = \frac{\mathbf{6000}}{\mathbf{K\text{-}factor}}$$

where,

KFR is the number that should be entered in to the **RATE SCALING** display (Display1)
K-factor is the number published by the manufacturer as the average K-factor for the transmitter.
100 is the constant if the time base is seconds.
6000 is the constant when the time base is minutes.
360000 is the constant when the time base is hours.

For example:

A flowmeter has the K-factor 2053.7 imp/Gal and the display should show Gallons/minute.

$$\mathbf{KFR} = \frac{\mathbf{6000}}{\mathbf{2053.7}} = \mathbf{2.921\ GPM}$$

When entering the number into the EMO-1005 keep in mind that the maximum number is 65000 (regardless where the decimal point is.)

Decimal Point Location

In order to change the scaling just enter the number, and change the decimal point location by pressing the DP key. After having the desired number in the display press the ENT key once.

Engineering Units

Now by pressing the SPC key the unit display can be changed to one of the following engineering units:

Hz, GPM, li/m, ci/m, cc/m, lb/m, lb/s, lb/h, gr/s, kg/m,
gr/m, mm/s, cm/m, in/m, ft/m, oz/m, Volt, mV, Amp, mA, PSI,
Bar, F, C, RPM, SSU, cSt, cPs.

Note: This is merely a convenient display function. The actual units are scaled thru the KFR factor.

Press **Enter** to exit the KFR scaling.

The default value for the KFR is 0000100.0 (Maximum= 65000) The default engineering unit is Hz (Hertz).

We recommend removing the insignificant decimal numbers often produced by calculator mathematics. These are mathematically redundant and may offer a misleading level of precision in the display. We recommend using a maximum of 4 digits, irrespective of the decimal point position.

Example: 60.675 is no good; better: 60.6
2.3456 is no good; better: 2.345

TOTALIZER SCALING - KFT (Display 2)

By answering with a 0 the scaling will be skipped.
By answering with a 1 the following display appears:

CURRENT KFR/UNIT XXXXXXXX. YYYY

where,

XXXXXXXX. is the current total scaling
YYYY is the selected engineering units

In order to make the EMO-1005 display show the desired engineering units, the most important thing to know is the K-factor of the transmitter that is being monitored. The K-factor is the relationship between the amount of impulses and the engineering unit.

To change the scaling just enter the number, (zero the display first) and to change the decimal point location press the **DP** key. After having the decimal point in the correct location press the **ENT** key once. Now, by pressing the **SPC** key the unit display can be changed to one of the following engineering units: Imp, Gal, lit, cin, cc, lbs, kg, gr, mm, cm, Inch, ft, Oz, Rev.

Press Enter to exit KFT programming.

The default value for the **KFT** is 00010000 (Maximum= 65000)
The default engineering unit is Imp (Impulses)

For example a flowmeter's K-factor could be 1998 imp/Gal or 123.22 imp/lit. A rpm pickup could be 55.0 imp/rev.

In order to calculate the KFT multiplier for the EMO-1005 apply the following formula.

$$\mathbf{KFT} = \frac{\mathbf{10000}}{\mathbf{K\text{-}factor}}$$

where,

KFT is the number that should be entered for **TOTALIZER SCALING** in display 2.
K-factor is the number published by the manufacturer as the average K-factor of the transmitter. If this is published in imp/gal the totalizer can still be set in, say cc's, by converting the K-factor to imp/cc.
10000 is a constant.

For example:

A flowmeter has the K-factor 10666.0 imp/Gal and the display should show gallons/minute.

$$\mathbf{KFT} = \frac{\mathbf{10000}}{\mathbf{10666.0\ Gal}} = \mathbf{0.9376\ Gal}$$

In the above example enter 9-3-7 (zero the display first, and don't enter the number 6) and then adjust the decimal point by pressing **DP** until the point appears at the correct position. After pressing the **ENT** key, the engineering unit may now be chosen by pressing the **SPC** key until the correct unit comes up. Now, by pressing the **ENT** key the KFT number and engineering unit will be stored in memory.

LIMITS PROGRAMMING (Display 3)

LIMITS? (none=0) RATE=1 TOTAL=2

By answering with a **0** the scaling will be skipped

By answering with a **2** go to the next section

There are a total of 4 limits per channel. Each of the limits can be a totalizer or rate limit. If the limit has been programmed for total and rate, the output will respond to the one that occurs first. This can produce unexpected limit initiation therefore you should be careful to avoid this type of programming duplication.

The limits are always programmed in:

- rate limit in Hertz 000000.00 Hz
- total limit in impulses 00000000. Imp.

In order to program the limits it is necessary to know the K-factor of the transmitter.

For example:

A flow meter has a K-factor of 8000 imp/Gal. Limit 1 should turn on when ever the flow exceeds 3.22 GPM and limit 2 should turn on when ever the totalized flow has reached 2.50 Gallons.

$$\text{LIMIT 1} = \frac{8000 * 3.22 \ \text{imp}}{60 \ \text{sec}} = 429.33 \text{ Hz}$$

LIMIT 2 = 2.50 * 8000 imp = 20000 imp

To check whether a limit is ON or OFF, go into the Status Display Mode for the channel in question. (see page 8)

WARNING!! Never enter two different limits, Rate and Total, under the same limit number.

RATE LIMIT

By answering with a 1 the following display appears:

```
RATE LIMIT NO    ?
ENTER 1 .....4
```

Select the rate limit that needs to be changed. Do this by pressing a number 1...4 Now the display will show the selected limit in the following fashion:

```
CURRENT RATE      Y
LIMIT   XXXXXX.XX
```

where,

Y indicates the limit number selected
XXXXXX.XX indicates the current rate limit in Hertz

To change the limit enter the right number and press **ENT** After entering the number the display returns to the Limit Main Menu.

The default values for all rate limits is 000000.00
The maximum number is 999999.99
The decimal is fixed at 000000.00

TOTAL LIMIT

By answering with a 2 the following display appears:

```
TOTAL LIMIT NO ?
ENTER 1 .....4
```

Select the total limit that needs to changed. Do this by pressing a number 1...4 Now the display will show the selected limit number (**Y**) and current rate in impulses. (**XXXXXX.XX**)

```
CURRENT TOTAL     Y
LIMIT   XXXXXX.XX
```

To change the limit enter the right number and press **ENT.** After entering the number the display returns to the Limit Main Menu.

The default value for all total limits is 00000000.
The maximum is 99999999.
The total limit decimal point is fixed at 00000000.

NEVER ENTER RATE AND TOTAL LIMITS UNDER SAME NUMBER

ANALOG GAIN - KFA (Display 4)

The Analog Gain (KFA) is the scaling between the frequency input and the analog output. *This is only valid in Monitor Mode -- in PID Mode, KFA controls the closed loop reaction time (P21).*

This should not be confused with the KFR factor

ANALOG GAIN (KFA) CURRENT=XXXXXXXX

The formula that describes the relation is as follows:

$$KFA = \frac{V * 33400}{f}$$

Frequency when Eng. Unit =Gallons

$$f = \frac{Imp/gal \times GPM}{60\ sec}$$

where,

V is the desired Output Voltage at frequency **f**: If 5V - use the GPM realistically achievable by your system to find f.

- **33400** is a constant

Once the right number is entered press **ENT**
The default value for KFA=00000167 (1000Hz = 5Volt)
The maximum KFA is 00065000

After the formula has been calculated and the correct number has been programmed in to the KFA, the Analog Output can be seen by going into the Status Display Mode. The Status Display shows a number from 0 to 1023 for the Analog Output. This number is the D/A converter input from the microprocessor. When the EMO-1005 is set for a maximum of 5 Volt DC on the Analog Output (Pin 10) then each step of the converter is equal to:

One step = 5Volt/1024steps = 4.8828mV

Therefore, if 1 Volt is measured on the Analog Output then the Status Display should be showing a count of 205 in the Analog Out (AO0205) position. (1 Volt = 205steps * 4.8828mV)

OFFSET ANALOG OUT (Display 5)

OFFSET ANALOG OUT CURRENT=XXXXXXXX

This display takes care of the Analog Offset adjustment. The full voltage span goes from 0 to 5V (0-20mA). Some applications however require a base voltage of 1 Volt (4mA). This base voltage can be programmed in the Offset Voltage. The EMO-1005 unit uses a 10 bit D/A converter for the Analog Output, where 0 Volt relates to a count of 0000 and 5 Volt is 1023. The offset is a number between 000 and 255 (0V to approximately 1.24V). This offset should be adjusted in the field. The offset has a connection with the gain Factor. In order to achieve the maximum span the following formula is applied:

$$\text{Analog Out} = AV - \frac{AV * (205 + ((205-Offset) / 4)))}{256}$$

where,

Analog Out is the offset voltage at zero frequency input
AV is the maximum Voltage (usually 5V)
The default value is 00000205 (4mA)

**** 1Volt = 205 steps * 4.8828mV/step
**** 4 mA = 205 steps * 19.5 μA/step

After having the right number press the **ENT** key

SAMPLE AMOUNT (Display 6)

SAMPLE AMOUNT CURRENT=XXXXXXXX

The sample amount can be entered in this display. This sample amount is a digital filter used to make the display rate steadier. The amount can be a number between 2 and 50. By increasing the number of samples used to produce an output into the display, the display response slows and the numbers are steadier and easier to read. **The default value is 00000008.** After having the right number press the **ENT** key.

WARNING:
SHOULD THIS VALUE BE CHANGED TO ZERO, THIS DISPLAY WILL READ ZERO

CUTOFF FREQUENCY (Display 7)

CUTOFF FREQ. CURRENT=XXXXXXXX

The cutoff frequency can be entered in this display. The cutoff frequency is used to remove a slowly decreasing rate being displayed when the flow is shut off - this is a display function only and pulses are not being counted. When actual flow stops, however, the unit will momentarily look for the next pulse and for a very short period, the displayed flow rate will tail away to zero. To avoid this confusing an operator, if the cutoff frequency is programmed, the display will drop to zero at frequencies below this. The cutoff frequency is a number between 000 and 255. This number relates to a frequency between 0.00 and 2.55 Hz.

The totalizer is not affected by the Cutoff Frequency. The default value is 00000050 (corresponding to 0.5 Hz).

After having the right number press the **ENT** key.

ANALOG IN GAIN (Display 8)

ANALOG IN GAIN CURRENT= XXXXXXXX

The Analog In Gain factor is used at the present time in the PI Mode as a relationship between Analog Input signal from a PLC or PC, if used, and the set value.

The formula is as follows:

$$\text{Analog In gain} = \frac{\text{Freq.} * 100}{205}$$

Freq. Is the actual frequency feedback from the flow meter (in Hz) at 20 mA analog input signal from the PLC. This can be established for most systems by fully opening the fluid regulator and reading the feedback frequency signal in status display mode.

WARNING: TO PID USERS: The default value is 00000000, however, if PID user has PLC analog Input control - ZERO in Analog-In Gain will cause failure. We suggest a value in the range 20-50. After having the right number, press the ENT key.

THE PROGRAMMING IS NOW OVER

CHANNEL MODE SELECTION

Each channel card installed in an EMO-1005 is a separate microprocessor controlled system. Each channel card has the option to designated as a **Monitor, PI Controller, Closed Loop Controller (CLC) or a Complex Ratio System**. To change a channel card to a different mode press the following key sequence:

CHA	->	DP	->	ENT	->	LIM

When this is done the following screen will appear:

MODE: 1=MON 2=PID 3=GON 4=TRA 5=RA

The next five sections will explain what happens when these numbers are selected.

For standard PID operations, select Mode #4, TRANSPARENT - This replaces Mode #2 for all uses.

MONITOR MODE (Select 1)

When a 1 is selected in the above screen, the channel card will be designated as a Monitor card. In the standard monitor mode the **EMO-1005** will read the incoming frequency, display the derived rate and total on the display, and adjust the Analog Outputs and Limits accordingly.

Using the 2 line display, both Rate and Total or Rate from 2 different channels could be monitored simultaneously - or any combinations of Rate, Total and Peak Rate.

THE EMO-1005 PID OPERATIONS (Select 4)

When a **4** is selected in the previous screen, the channel card will be designated as a PI Controller with the Transparent option.

The PI Controller with the Transparent option works the same as the standard PI - controller except that the mode, when activated, takes the Analog Input and diverts it to the Analog Output. This feature even overrides the HOLD signal. By doing this the EMO-1005 channel card becomes transparent. This is used to override PID control mode during the flushing cycle. To do this the Limit 4 Output (pin 11) must be connected to +15V (pin 1) and the RESET (pin 9) must be connected to the Limit Common (pin 15). This mode works well when testing the system components. As long as the Limit 4 is connected to +15V, the PI Controller will not start to regulate. (See Appendix J).

This is a very useful function for system evaluation and troubleshooting because PLC signal commands can be routed directly through the unit to the other system components and the response can still be evaluated via the EMO status display mode. For example the fluid regulator limitations can be easily investigated in this manner.

The Transparent mode is used in applications where the rate (flow, rpm, speed, etc...) has to be controlled and maintained. The PI-controller uses the frequency coming from the transmitter, as a feedback signal, referred to as **CURRENT RATE**. The unit puts out an analog signal (4-20mA/0-5V) to correct for the difference between **SET VALUE** and **CURRENT RATE**

SET-VALUE can be programmed via one of the following methods:

A. 4-20mA into Analog Input (Pin 5 & 6) (From PLC)
B. Programmed values (SET VALUE1/SET VALUE2) through the keyboard entry. Programmed in Hz.
C. Set value can be entered through the RS-422 (RS-232) connection.

When using a channel as a PID controller it still works as a totalizer unit and rate indicator.

Some input pins and programmed values will have a different effect when the channel is used as a PID controller.

(See Appendix J & Table Following)

The limits in monitor mode have no validity in PID mode, the following table shows their revised functions and programming locations.

MONITOR MODE	CLOSED LOOP (PID)
Rate Limit 1 (Hz) Rate Limit 2 (Hz) Rate Limit 3 (Hz) Rate Limit 4 (Hz)	Set Value 1 (Pg. 20) Set Value 2 (Pg. 20)
Total Limit 1 (Impulses) Total Limit 2 (Impulses) Total Limit 3 (Impulses) Total Limit 4 (Impulses)	Initial Kick (Pg. 22) Integral Adder for I-Part (Pg. 21) Initial Kick Threshold (Pg. 23)
Totalizer Reset (Pin 9)	Auto Hold of last Analog Value

When operating in Monitor Mode, there are a total of 4 Limits available for use. Each one can be programmed for both Rate and Total Values in separate locations. However, to avoid operator confusion, it is recommended to maintain separation.

Use each Limit number for only one alarm condition.

The formula used in **PID Mode** to achieve a set value from a frequency input signal **(CURRENT VALUE)** is as follows:

AnalogOut=AnalogOutOld+KFA* (SET VALUE-CURRENT VALUE) + I-part

where,

AnalogOutOld is the Analog Output value prior to the current calculation.
KFA is the gain factor
SET VALUE is a selected programmed value.
CURRENT VALUE is the last calculated rate value.
I-part is the programmed adder.

Integral Adder, I-Part

In most applications, an I-part is not necessary, but if the KFA is very low, an I-part = 1 could be used. The above formula will be evaluated every rising edge of the input frequency. This feature makes the EMO-1005 PI-unit react faster at higher frequencies and slower at lower frequencies.

KFA in Monitor mode is the gain factor for the Analog Output.

In the PI-mode KFA becomes the closed loop gain factor, and an increase in the KFA results in a quicker reaction time and in a "stiffer" system. However, whenever the KFA has too big of a value, the system tends to show unstable behavior (swinging).

Initial Kick

The PI-controller will output the value in total limit 2 (P. 21) if there is a set value and nothing is being received from the feedback loop. This is called the **initial kick** and is meant to >kick start= some fluid regulators, which will resist an initial opening when starting from a zero flow condition. The **initial kick** can be programmed from 0000 to 1023 (where 0000=omA and 1023=20mA). In units prior to AUGUST 1987, the **initial kick** could be programmed only from 000 to 255.

Auto Hold

In PID mode, if the feedback signal is cut off abruptly, the software will maintain the last analog output value. This is an advantage in an ON/OFF operation since the unit does not have to start regulating again from zero when the signal is given to restart. An example of an ON/OFF system is a paint spraying gun.

Manual Hold

There is an additional **HOLD** function for applications where ON-cycles are extremely short or where during the flush cycle no control is desired. The **HOLD** signal is overriding in a sense that nothing is able to change the Analog Output while **HOLD** is on. This function can be initiated with 15 V to pin 12, and pin 9 jumped to pin 15 (See Appendix J).

The EMO-1005 PI-mode is fairly uncritical. AW Company, however, recommends some prior knowledge of Closed Loop System controlling before hooking us the PI-mode channel. The response times are dependent upon the following things:

- Resolution of the transmitter
- Mechanical delays in the system
  - (boosters and I/P converters or the hose/pipe length between components)
- Gain factors (KFA)

EMO-1005 SOFTWARE CHANGE

A new programmable feature has been added to the EMO-1005 software.

It is a Programmable Threshold for the initial kick value used in PI and Closed Loop Mode. (See Initial Kick, pg. 22). While most good fluid regulators are supposed to crack open at 4mA, there is much inconsistency to be found. The earlier threshold value was fixed at 5.0 mA -this is now user programmable. If nothing is programmed here (0000), **a threshold default value of 5.0 mA (256)** is still used.

The location of the programmable value is in Total Limit #4.

The range is from 0000 to 1023 steps (Where 0000 = 0mA, and 1023 = 20mA, 51 steps = 1mA).

In the software prior to these changes, the Initial Kick (programmed in Total Limit #2) was activated providing the following 3 system conditions were met:

1. **A flow set point had been initiated.**
2. **Analog output was below 5.0 mA (256 steps).**
3. **Actual flow was zero.**

Conditions 1 & 3 remain unchanged - #2 is now programmable

Example:

The **Initial Kick** (in Total Limit #2) is set to 615 (12 mA).
The **Threshold** (in Total Limit #4) is set to 358 (7 mA).

The current Analog output is at 5.5 mA (281 steps), but the actual flow is at zero. The valve has not opened. The Analog Output is BELOW the Threshold and now the Initial Kick will take effect. The Analog Output will go immediately to the Initial Kick value. In Total Limit #2 - 12 mA (615 steps).

The new version for Channel 1 software is 2.0 and for Channel 2 and over it is 1.4. This is determined by removing the channel card, the software version is indicated on the EPROM chip. See Appendix F for location.

GUN-ON PI CONTROLLER (Select 3)

When a 3 is selected in the previous screen, the channel card will be designated as a PI Controller with the Gun-On option. The only difference between this and the standard PI Controller is the Gun-On feature which makes the Analog Output increase until the EMO-1005 starts to see a feedback frequency. When the EMO-1005 is in this mode, the initial kick has no affect on the Analog Output. In order to turn on the Gun-On feature, the Limit 4 (Pin 11) must be connected to pin 1 (+15V) and the RESET (pin 9) must be jumped to the Limit common (pin 15). When the EMO-1005 sees a set signal but no frequency return it immediately starts to increase the Analog Output until a feedback frequency is recognized.

COMPLEX RATIO MODE (Select 5)

This is a monitoring function - not closed loop control of ratio delivery.

This ratio mode applies to channel one only; it takes the rate of channel 1 and divides it with the rate of channel 2. The channel 1 outputs are affected by the ratio calculations as shown below:

$$\textbf{Analog Out} = \frac{\textbf{KFA * KFR Ch1 * RATE Ch1}}{\textbf{KFR Ch2 * Rate Ch2}}$$

Complex Ratio mode has no effect on the display (Simple Ratio does - pg. 7). In this mode, however, the outputs are also modified. In Complex Ratio mode, the values programmed in the dour totalizer limits will be compared to the Analog Output numeric value.

The limits will be turned ON if the Analog Output value is larger than the programmed totalizer value -- this can provide a ratio alarm indication.

The Analog Output is a number between 0000 - 1023, where 0000 equals 0 Volt and 1023 equals 5 Volts. If channel 2 is not inserted or the rate of channel 2 is zero, then the output of channel 1 is 5 volts (1023 steps). If the Analog Offset is programmed, then the regular offset rules apply.

Example: A two component flow measurement system is needed and flow 1 is two times the flow 2. Also, a limit alarm is needed for a 5% high and a 5% low measurement. Then channel 1 of the EMO-1005 would be programmed as a Complex Ratio Monitor. The flow 1 frequency would be connected to the channel 1 frequency input and the flow 2 would be connected to channel 2 frequency input. By using the ratio analog out formula, the KFA (Analog Output) can be set to give a 2.00 VDC (2V = 410 steps) output when the ratio is correct. Then, by wetting totalizer limit 1 to 431 steps (2V +5%) and totalizer limit 2 to 390 steps (2V -5%), the two limits will give a signal when this margin has been exceeded.

** CAUTION ** Never program the channel 1 card to be a Complex Ratio Monitor unless the channel 2 card is installed. If this is done the EMO-1005 unit will lock up.

CLOSED LOOP CONTROL MODE (CLC)

The CLC mode has been adapted to the EMO-1005 for extremely slow closed loop applications. In some applications (fluid) where the distance between the I/P converter and the regulator is more than 40 feet and the pneumatic system is not quick enough in response, the standard PI loop will not do the job. The CLC mode has one major difference to the standard PI mode in that the corrections are done by a percentage to the error rather than proportionally.

For example:

If a set value (Analog In) is calling for a flow rate of 20 liquid ounces but the feedback frequency is only 18.2 liq.oz. when sending out 10mA's, then the CLC would correct the Analog Output as follows:

$$\textbf{New Analog Out} = \textbf{Old Analog Out} + \frac{\textbf{Set Value - Current Value}}{\textbf{Set Value}} * \textbf{A}$$

where,

A is the highest value of the Analog Output. (Usually 5VDC)

After making the corrections, the CLC waits until the mellow frequency (average) catches up with the actual frequency. After the catch-up has been achieved, within the death band limits, the CLC is then ready for a new round of calculations.

There are a great many applications which show a lag time before any reaction in the system can be seen. To take care of this problem, a programmable lag time factor has been added to the CLC mode. In the CLC mode, a change at the Analog Input will immediately cause a change in the Analog Output. Again, the change on the output is based on a percentage.

CLC Parameters

Totalizer Limit # 2	= Initial kick	(205=4mA...1023=20mA)
Totalizer Limit # 1	= Lag time	(0100 - 0255)
Sample amount	= Average	(005 -040)
Cutoff	= Death band	(100=1Hz...255=2.55Hz)
Analog In Gain	= Scales Analog	Input

The initial kick is used to start a system regulating. See the section "THE EMO-1005 PID OPERATIONS", page 20, for more information about the initial kick.

The Cutoff is used to stop the unwanted hunting of the CLC mode. When Cutoff is set, the number in the Cutoff is translated into a frequency. The number in the Cutoff is the margin where the EMO-1005 will stop regulating and will hold a steady Analog Output.

By increasing the Sample amount, the Lag time reaction becomes slower.

By increasing the Death band the unwanted hunting will be avoided.

** CAUTION ** Changing from one mode to another changes some of the inputs to outputs therefore, please make sure which mode the channel card is in before hooking up external signals.

THE EMO-1005 LINEARIZER

Some systems have un-linear transducers for the rate or frequency. To solve this problem the **EMO-1005** was developed with a ten point Linearizer that can be programmed with an error of +/- 12.7%.

USING THE LINEARIZER

The Emo-1005 Linearizer can be used with any of the channel mode selections listed. This means that the unit can linearize the feedback frequency of a PID controlled system or correct for error of one component in a two component ratio system. When the unit is turned on, the initialization process designates whether the Linearizer is ON or OFF. If the Linearizer was previously being used then it will be functional when the unit is again turned on. The un-linearized frequency input can be viewed in the Status Display Mode. The Linearizer feature is used mainly in connection with "un-linear" transmitters. There are plenty of transmitters around that show a variation in the K-factor with varying rates. In order to use the Linearizer effectively the transmitter manufacture or supplier should supply a calibration sheet that would look as follows (*this is just an example*):

FREQUENCY Hz	RATE GPM	K-factor Imp/Gal	ERROR %
10	.26	2037.7	-5.2
100	2.60	2157.7	+0.5
500	13.00	2100.0	-2.5

If the percentage of error is not shown it can be calculated using the average K-factor.

PROGRAMMING THE LINEARIZER

To enter the Linearizer mode press the following key sequence:

CHA	->	DP	->	ENT	->	DP

Now the display shows:

```
LINEARIZER !!!
1=CL 2=AC 3=DEAC
```

By pressing the **1** key the Linearizer will be cleared. This means all error values are set to +12.7% and all frequency points are set to zero.

By pressing the 2 key the Linearizer will be activated.
By pressing the 3 key the Linearizer will de deactivated.

Regardless of the key pressed the following display will come up:

```
LINEARIZER PROG?
0 = NO   AND 1 = YES
```

If the 0 key is pressed the Linearizer selection done above will go into effect and the unit returns to the regular operating screen.

If the 1 key is pressed the unit enters a 10-point programming routine. When the 10-point programming routine is entered there is no short cut, which means, all of the errors and points have to be reviewed and entered.

The following display will appear:

```
ERRxx=00000yy.y%
POIxx=zzzzz.zzHz
```

where,

xx is the current point 01 through 10
yy.y is the error -12.7% to +12.7% at point xx
zzzzz.zz is the frequency at which the error xx occurs.

There are 10 points to be programmed. The first thing to be entered is the percentage of error. To change the sign use the DP key. After the correct percentage of error is put in the unit and the correct sign is selected (+ or -) then press the ENT key. On the second line is the frequency at which the above error occurs. Enter new frequency and press the ENT key. All ten points will show up, but only program the points that are necessary. Leave all unused points at zero Hz.

The Linearizer uses linear interpolation between points, which means a straight line between two error points.

**** IMPORTANT ** The channel that will be linearized is the one on the display line 1 !!!!!**

THE EMO-1005 SERIAL PORT

The standard EMO-1005 has a RS-422 serial port. AW-Company decided to use the RS-422 as a standard because of higher noise immunity and better acceptance in industrial applications.

General characteristics for the EMO-1005 serial port.

Signals:	RS-422 Standard with the following components Receiver: SN75157 Transmitter:SN74159 (tri-state output) Receiver has no pull-ups or pull-downs Transmitter in tri-state when no action
Baud Rate:	Programmable, 2400, 4800 or 9600 baud
Stop bits:	1 Stop bit
Start bits:	1 Start bit
Data bits:	8 Data bits
Parity:	No Parity
Echo:	Supports Echo Mode (Receive ---> transmit)
Module Offset:	Supports large scale systems with offset
Protocol:	OPTOMUX-like protocol format

The serial port is used in conjunction with a host computer.

SERIAL PORT PROGRAMMING

To enter serial port programming press the following key sequence:

CHA	->	DP	->	ENT	->	1

The display will show:

BAUD RATE: 9600=1 4800=2 2400=3

By pressing 1,2 or 3 the indicated baud rate can be programmed and the display will automatically go to the next step.

ECHO ON=1 OFF=0 PRESS 1 or 0

Echo mode should be selected in the trouble shooting session. In Echo mode the EMO-1005 transmits exactly the same string it receives. The next step is:

ACTIVATE SERIAL 1=ON 0=OFF

After pressing 1 or 0 the EMO-1005 unit goes into the Receiver/Transmitter display mode and the beginning usually looks as follows:

```
RXXXXXXXXXXXXXXX
TXXXXXXXXXXXXXXX
```

If left in this mode the serial communication can be viewed. The Receiver is on the upper line and the Transmitter on the lower line.

If the text ORFE is right after the R it means that the unit has an over run/framing error. This error usually occurs when there is nothing hooked up to the serial port or when the baud rate is not right.

In order to leave the above display mode just press the **ENT** key. Now the display will show:

```
CUR OFFSET   000
NEW OFFSET   000
```

At this point a new offset can be entered (a number 000 to 256). The offset is necessary if there is more than one rack mounted unit involved. The channel address is calculated in the following way:

Send Address = Channel Number + Module Offset

Example: If you have two four channel units, unit one will have **offset=0, channel # 1 - 4**. Unit two will have offset=4, channel 5 - 10 (Send address Ch(5)=Ch(1) + offset(4)

By pressing the **ENT** key the unit goes back into display mode.

IMPORTANT!! If you are using only ONE EMO-1005 do NOT enter anything in the OFFSET. If you do - your serial communication will not work.

SERIAL PORT CONNECTION WIRING

The serial port connection is established through the 9 pin D-sub connector on the back panel of the unit.
The pin termination is as follows:

PIN 1 - No connection
PIN 2 - RX TTL level (EMO receiving)
PIN 3 - TX Inverted RS-422 (EMO transmitting)
PIN 4 - RX Inverted RS-422 (EMO receiving)
PIN 5 - GND for shielding
PIN 6 - TX TTL level (EMO transmitting)
PIN 7 - TX RS-422 (EMO transmitting)
PIN 8 - RX RS-422 (EMO receiving)
PIN 9 - GND signal

PROTOCOL FORMAT

The EMO-1005 protocol format follows OPTOMUX by the OPTO-22 company.
The EMO-1005 is treated as a smart front end and the host communication is always initiated by the host computer.

The following are basic commands and answers.

Reading a channel with the host computer:

>03K0F3403XXcr
^..... start of text always the > sign
^^..... channel address number (00 through FF)
^..... read command is K (J is write)
^^^^.....address that should be read 0000-FFFF
^^..... how many bytes to be read 00 through 0D
^^...checksum for the string 03K0F3403
^.. carriage return (decimal 13)

Answer back from the channel would look like this:

A03FF89XXcr
^..... every answer back starts with an **A**
^^..... low byte (at address 0F34)
^^..... next byte (at address 0F35)
^^.....next byte (at address 0F36)
^^.....checksum for the string 03FF89
^^....carriage return

Writing with the host computer:

```
>01J03340F6587XXcr
^..................  start of text always > sign
 ^^.................  channel number that should be written to
   ^................  J = writing into channel (K = read)
    ^^^^............  address to write to
        ^^.........  byte written to 0334
          ^^.......  byte written to 0335
            ^^.....  byte written to 0336
              ^^...  checksum for string 01J03340F6558
                ^^.  carriage return
```

If write operation was successful the channel answers with an**:** Acr

The following error messages have been implemented in the EMO-1005 protocol:

N01cr - Undefined command (something else than K/J)
N02cr - Checksum error
N03cr - Non printable ASCII character

There is a booklet published by OPTO 22 on the protocol format.

CHECKSUM CALCULATION

Calculating the previous string variable for the read command:

```
>03K0F3403XXcr
^^^^^^^^^..... these characters have to be put into the calculation.
```

Add the values for the ASCII Decimal variables as follows:

HEX	0 + 3 +K + 0 + F + 3 + 4 + 0 + 3
ASCII	48 + 51 + 75 + 48 + 70 + 51 + 52 + 48 + 51 = 494

To calculate the final checksum, convert the **decimal** number 494 into **HEX** (494=1EEh) and take the **last two** characters (**EE**) for the checksum.

The final string would look like this:

>03K0F3403EEcr

These are the ASCII characters needed when working with the EMO-1005

ASCII	Decimal	ASCII	Decimal
0	48	A	65
1	49	B	66
2	50	C	67
3	51	D	68
4	52	E	69
5	53	F	70
6	54		
7	55	J	74
8	56	K	75
9	57		

BASIC PROGRAM FOR TESTING THE SERIAL PORT.

The BASIC program below will help test the communication port with a IBM PC compatible computer. The program can be used in connection with BASIC, BASICA, GWBASIC or any other reasonably standard PC BASIC.

```
10 REM *** EMO-1005 Serial port test program ----------
20 REM
30 OPEN "COM1:9600,N,8,1,RS,CS,DS,CD" AS #1
40 REM 9600 baud/no parity/8 data bits/1 stop bit/no hand shakes
50 INPUT "Enter string to send ",T$
60 REM for example 01K006304. This will read Totalizer channel 1
70 REM the > sign and carriage return is added later in the
80 REM program.
90 REM the next 4 lines calculates the checksum
100 FOR X=1 to LEN(T$)
110 NUM=NUM+ASC(MID$(T$,X,1))
120 NEXT X
130 CHK$=HEX$(NUM-(FIX(NUM/256)*256))
140 REM CHK$ carries the checksum as a string
150 REM now send the message
160 PRINT#1,;">";T$;CHK$;CHR$(13)
170 REM and print the message on screen
180 PRINT "Sent : ";">";T$;CHK$;CHR$(13)
190 PRINT "Waiting for replay....."
200 LINE INPUT#1,X$
210 PRINT "Received : ";X$;CHR$(13)
220 CLOSE #1
230 END
```

Before running the program make sure all hardware aspects are OK and the EMO-1005 is hooked up correctly.

IMPORTANT ADDRESSES

WARNING --- IMPORTANT --- WARNING --- IMPORTANT --- WARNING
The communication port does not discriminate any addresses. This means that any address can be written to as well read from. Certain addresses will change the operation of the EMO-1005 drastically. Caution is recommended. Double check your programming.

The bytes are always arranged such that the low byte is first and then the more significant byte.

Example: the Totalizer is at 0063 0064 0065 0066 LSB MSB

Address In HEX	Number of Bytes	Description
0053	2	Transparent Analog Register
0055	2	Analog Output
0063	4	Totalizer (In impulses)
0067	3	Frequency Instant (In 0.00 Hz)
006A	1	Analog Input, 00=0V, FF=5V
006B	3	Peak Frequency (In 0.00 Hz)
006F	3	Frequency Mellow (In 0.00 Hz)
0074	1	Analog Output Offset
0075	1	Mode selector: 01=Mon, 02=PID, 03=Gun-On
		04=Trans, 05= Ratio
0076	1	Display Cut Off Frequency
0077	1	Sample amount for Mellow Frequency
0078	3	Flow Limit 1 (In 0.00 Hz)
007B	3	Flow Limit 2 (In 0.00 Hz)
007E	3	Flow Limit 3 (In 0.00 Hz)
0081	3	Flow Limit 4 (In 0.00 Hz)
0084	4	Total Limit 1 (in impulses)
0088	4	Total Limit 2 (in impulses)
008C	4	Total Limit 3 (in impulses)
0090	4	Total Limit 4 (in impulses)
0094	2	Analog Output Gain
009B	2	Analog Input Gain
009D	1	Linearizer Activator, FF=active
009E	3	Point 1 Linearizer (In 0.00 Hz)
00A1	1	Point 1 error, E3h=-10%, 7Fh=0%, 1Bh=+10%
009E	3	Point 2 Linearizer
00A1	1	Point 2 error, E3h=-10%, 7Fh=0%, 1Bh=+10%
.....	.	.....
00C2	3	Point 10 Linearizer
00C5	1	Point 10 error, E3h=-10%, 7Fh=0%, 1Bh=+10%

These addresses are located in every channel..

Example:

>03K006304XXcr Reads channel 03 totalizer
>01K006304XXcr Reads channel 01 totalizer

The next information is battery backed in Channel 01 even though it concerns channel 01 through FF.

Below is a table where to find this information located in the Channel 1 memory.

in HEX		Address for				
Ch1	Ch2	Ch3	Ch4	Ch5	.....	Description
0552	05D2	0652	06D2	0752	.....	Display KFT factor, 2 bytes
0554	05D4	0654	06D4	0754	.....	Display decimal p., 1 byte
0555	05D5	0655	06D5	0755	.....	Display KFR factor, 2 bytes
0557	05D7	0657	06D7	0757	.....	Display decimal p., 1 byte
0558	05D8	0658	06D8	0758	.....	Eng. Units Total 1 byte
0559	05D9	0659	06D9	0759	.....	Eng. Units Flow 1 byte

HARDWARE HINTS

The EMO-1005 internally has 1-5 microprocessors therefore, it is very important to pay attention to proper signal wiring and shielding.

SIGNALS AND SHIELDING

The standard EMO-1005 is delivered with two frequency inputs. Pin 4 of any channel card is an opto-coupler input where 5-30Volts turn on the opto-coupler. This input is used mainly for the ZHM series flowmeters distributed by the AW Company. The frequency return from a ZHM meter can be directly connected to this input. Pin 3 is an adjustable threshold input. This input has the ability to be adjusted to three different sensitivity levels. The highest level is 3.25Volts. This is used for signals that have a amplitude swing from 3.5-50Volts maximum. This means that the incoming wave form must have an amplitude of at least 3.25V (3.5V is better). If the signal source is less that 3.5V the threshold has to be adjusted lower. The next lower threshold is 1.7V. The lowest threshold is mainly used for inductive pick-ups. This threshold is set at 50mV. Refer to drawing EMO10904, Appendix F, for the location of the sensitivity adjustment jumpers. The frequency input signal should always be referenced to the ground connection (pin 2). Most applications require signal shielding. A solid aluminum wrap shielding will work fine. The shield should be connected to pin 2 on the respective channel terminal. **Do NOT connect the shielding at the transmitter.**

IMPORTANT! NEVER CONNECT THE SHIELD TO GROUND IN BOTH ENDS ! THAT COULD PRODUCE UNWANTED OSCILLATIONS IN THE SIGNAL WIRES!

GROUNDING CONSIDERATIONS

The grounding is the most important consideration in an installation where microprocessor technology is applied. The EMO-1005 is a panel mounted unit and therefore the casing is connected to the sub-panel. If the sub-panel is metal this should be grounded. This way the EMO-1005 housing is grounded. If the sub-panel is non-conductive the rear panel terminal block for power supply, pin 1, can be used for grounding.

In case of strong EMI (ElectroMagnetic Interference) it is recommended to use an EMI filter in the 110V/60Hz (220V/50- 60Hz) supply line. These filters can be purchased at any local electronic parts supplier.

A few important hints:

- Always establish a solid ground in the installation.
- Place the EMO-1005 as close as possible to the central ground.
- Never pull the signal lines close to High-Voltage wires.
- Use shielding on all signal wires.
- Never plug an EMO-1005 in the same outlet with motor controls or lighting circuits. A separate 110V line is recommended.

BACK PANEL DETAILS

Before hooking up the EMO-1005 it would be advisable to read this complete section.

The EMO-1005 consists of a POWER SUPPLY CARD and at least one CHANNEL CARD. The regular EMO-1005 could be equipped to hold 4 CHANNEL CARDS. In the expanded chassis model the case can hold as many as 14 Channel cards. The 5" units holds up to 4 channels, the 10" unit up to 12 channels, and the 15" unit up to 14 (15) channels. Looking from the rear into the unit the cards are arranged as on drawing EMO10903, Appendix E. The EMO-1005 is a CMOS based computer. This means the unit will draw very little power from the 110VAC line. A separate 20 Amp. line is recommended for the unit although the power consumption will be less than 2 Amps.

The location next to the power supply card can only have the Channel 1 card installed.
The other locations are for channel 2 and up. Any of these channel card can be in any of these locations and still work properly. But, it is advisable that channel 2 is next to channel 1 and so on. Doing this will keep the channel numbers in order. If there is a question about the channel number designation of a card, pull the card out of the chassis and read the label on top of the EPROM IC chip located on the card (see drawing EMO10904, Appendix F, for location)

EMO-1005 TROUBLESHOOTING

CAUTION!!!
The Power-supply card has live 110 VAC on the card.
Disconnect the power cord before opening the EMO-1005.

Symptom	Possible Cause	Correction
No display at all.	No 110 VAC power to unit	Check 110 VAC Supply
	Blown main fuse in power supply All three LED=s on supply card OFF	Check fuse F1
No display at all & Analog Output is negative	+12 VDC/+5VDC supply fuse blown LED D1 and D3 off	Check fuse F2
Analog 4-20 mA Output very High	-12 VDC supply fuse blown, LED D2 OFF	Check fuse F3
Analog 5 V Output very High	-12 VDC supply fuse blown, LED D2 OFF	Check fuse F3
Zero reading on rate or total. LED on channel card is blinking.	KFR or KFT set to Zero KFR and KFT must NOT be Zero	Correct KFR and KFT Default KFR=100, KFT=10000
Zero reading on display. LED on channel card is NOT blinking.	Faulty pick-up, wiring wrong	Check pickup, Check wiring
	Frequency amplitude too low	Wire from pickup is too long
No frequency input reading on pin 4. LED on channel card is NOT blinking.	Frequency amplitude too low Try pin 3 input.	Pin 4 amplitude must be at least 4.5 V p-p
No frequency input reading on pin 3 LED on channel card is NOT blinking.	Sensitivity adjustment wrong.	Check jumper J10-J12 on channel card.
Zero reading of both Rate and Total.	Sample amount set to Zero KFR set to Zero	Set Sample amount to more than Zero (Default=8)
Wrong reading of Rate or Totalizer.	KFR or KFT programmed wrong	Check formula for KFT or KFT Check programmed value
No Analog Input reading.	Faulty wiring or sensor KFA set to Zero	Check Status display, if NOT OK, check sensor/wiring. Check with mA meter on pin 5. If NO reading, check wiring/sensor.
No Analog Output signal.	Faulty wiring/receiver	Check wiring/receiver. Check with Volt meter between pin 6 and pin 7. Over 12 VDC = Output OK, but open current loop (1-5 VDC = 4-20 mA)
None of the Limit outputs are working	Common connection on pin 15 missing/bad	Check wiring
Lost configuration Data Display ARam and no Bat≅ at power-up	RAM battery dead	Return to AW-Company for repair

One of the Limits output is not working	External Wiring Wrong Faulty Opto-coupler	If Status display is OK Check external wiring
		If Status display and wiring is OK, return to AW Company
Random number comes up when a number is entered in programming mode.	The number entered is too large.	Check programming section for maximum allowable number.
Serial communication does not work.	If only ONE EMO-1005 is used and an offset value has been programmed.	Offset must be set to Zero when only one EMO-1005 is used.
	Serial communication is turned off.	Check Serial Port Programming.
	Echo turned ON, Baud rate wrong	

Three easy steps to check a system with an EMO-1005, a pickup and wiring in between.

1. With a paper clip, touch between pin 2 to pin 4 (or pin 3, if used) via the 15 pin connector on the back of the **EMO-1005**, wiggle the clip and see if there are any pulses registered on the display. If so, the **EMO-1005** is working fine, go to step 2. If no pulses are registered, please call AW company for technical assistance or return authorization.

2. Disconnect the pickup from its Amphenol connector, and use the paper clip between the A and C holes on the connector. If wiring is OK, pulses should be registered on the **EMO-1005** display. Go to step 3. If no pulses, check the wiring from the connector to the **EMO-1005.**

3. Unscrew the pickup, and replace the connector. With a screw driver or any other ferrous material move it in front of the pickup sensor, no more than 1/8" from the sensor. If pulses are registered on the **EMO-1005**, check if the flowmeter is turning and if the pickup is screwed all the way into the flowmeter. If no pulses are registered on the **EMO-1005**, the pickup is probably defective.

LIMITED WARRANTY

AW Company warrants the EMO-1005 flow computer to be in good working order for a period of 1 (one) year from the date of purchase from AW Company or an authorized AW Company distributor. Should the EMO-1005 fail to be in good working order at any time during this 1 year warranty period, AW Company will, at its option, repair or replace the EMO-1005, at no additional charge except as set forth below. Repair parts and replacement products will be furnished on an exchange basis and will be reconditioned or new. All replaced parts and products become the property of AW Company. This limited warranty does not include service to repair damage to the EMO-1005 resulting from accident, disaster, abuse, or a Non-AW Company modification to the EMO-1005.

Limited warranty service may be obtained by delivering the EMO-1005 during the 1 year warranty period to AW Company and proof of purchase date. If this product is delivered by mail, you agree to insure the EMO-1005 or assume the risk of loss or damage in transit, to prepay shipping charges to the warranty location and to use the original shipping container or equivalent.

Contact:

AW Company
8809 Industrial Dr.
Franksville, WI 53126

Phone: (262)884-9800
Fax: (262)884-9810

For further information.

ALL EXPRESS AND IMPLIED WARRANTIES FOR THIS PRODUCT INCLUDING THE WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO A PERIOD OF 1 (ONE) YEAR FROM THE DATE OF PURCHASE, AND NO WARRANTIES, WHETHER EXPRESS OR IMPLIED, WILL APPLY AFTER THIS PERIOD. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU.

IF THIS PRODUCT IS NOT IN GOOD WORKING ORDER AS WARRANTED ABOVE, YOUR SOLE REMEDY SHALL BE REPAIR OR REPLACEMENT AS PROVIDED ABOVE. IN NO EVENT WILL AW COMPANY BE LIABLE TO YOU FOR ANY DAMAGES, INCLUDING ANY LOST PROFITS, LOST SAVINGS OR INCIDENTAL OR CONSEQUENTIAL DAMAGE ARISING OUT OF THE USE OR INABILITY TO USE SUCH PRODUCT, EVEN IF AW COMPANY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, OR FOR ANY CLAIM BY ANY OTHER PARTY.

THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH MAY VARY FROM STATE TO STATE.

QUICK REFERENCE KEY SEQUENCES

STATUS DISPLAY MODE

CHA -> DP -> ENT -> KFR

CHA -> 01, 02, etc = Channel Number

PROGRAMMING

CHA -> DP -> ENT -> KF A

SPC = Engineering Units

DP = Decimal Point

CHANNEL MODE SELECTION

CHA -> DP -> ENT -> LIM

PROGRAMMING THE LINEARIZER

CHA -> DP -> ENT -> DP

SERIAL PORT PROGRAMMING

CHA -> DP -> ENT -> 1

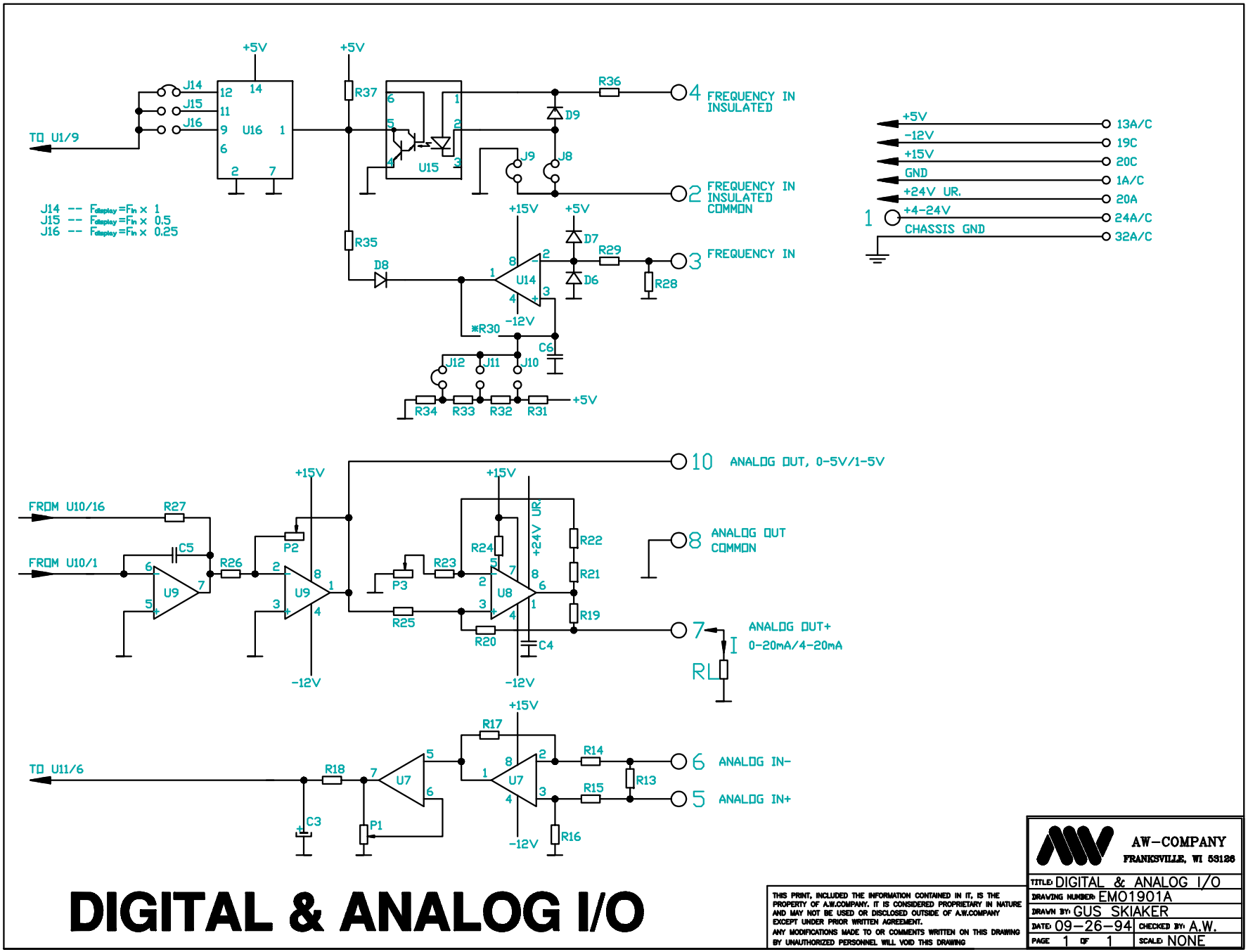
APPENDIX A

PROGRAMMABLE PARAMETERS

PARAMETER	DEFAULT	YOUR PROGRAMMED VALUE
RATE SCALING (KFR)	0000100.0	
TOTALIZER SCALING	00010000	
RATE LIMIT 1	00000000	
RATE LIMIT 2	00000000	
RATE LIMIT 3	00000000	
RATE LIMIT 4	00000000	
TOTAL LIMIT 1	00000000	
TOTAL LIMIT 2	00000000	
TOTAL LIMIT 3	00000000	
TOTAL LIMIT 4	00000000	
ANALOG GAIN (KFA)	00000167	
OFFSET ANALOG OUT	00000205	
SAMPLE AMOUNT	00000008	
CUTOFF FREQUENCY	00000050	
ANALOG IN GAIN	00000000	
LINEARIZER ERR. POINT 01	0000012.7	
LINEARIZER POI. POINT 01	00000000	
LINEARIZER ERR. POINT 02	0000012.7	
LINEARIZER POI. POINT 02	00000000	
LINEARIZER ERR. POINT 03	0000012.7	
LINEARIZER POI. POINT 03	00000000	
LINEARIZER ERR. POINT 04	0000012.7	
LINEARIZER POI. POINT 04	00000000	
LINEARIZER ERR. POINT 05	0000012.7	
LINEARIZER POI. POINT 05	00000000	
LINEARIZER ERR. POINT 06	0000012.7	
LINEARIZER POI. POINT 06	00000000	
LINEARIZER ERR. POINT 07	0000012.7	
LINEARIZER POI. POINT 07	00000000	
LINEARIZER ERR. POINT 08	0000012.7	
LINEARIZER POI. POINT 08	00000000	
LINEARIZER ERR. POINT 09	0000012.7	
LINEARIZER POI. POINT 09	00000000	
LINEARIZER ERR. POINT 10	0000012.7	
LINEARIZER POI. POINT 10	00000000	
SERIAL PORT BAUD RATE	9600	
SERIAL PORT ECHO	OFF	
SERIAL PORT ON/OFF	OFF	
ADDRESS OFFSET	000	

APPENDIX B

APPENDIX C



DIGITAL & ANALOG I/O

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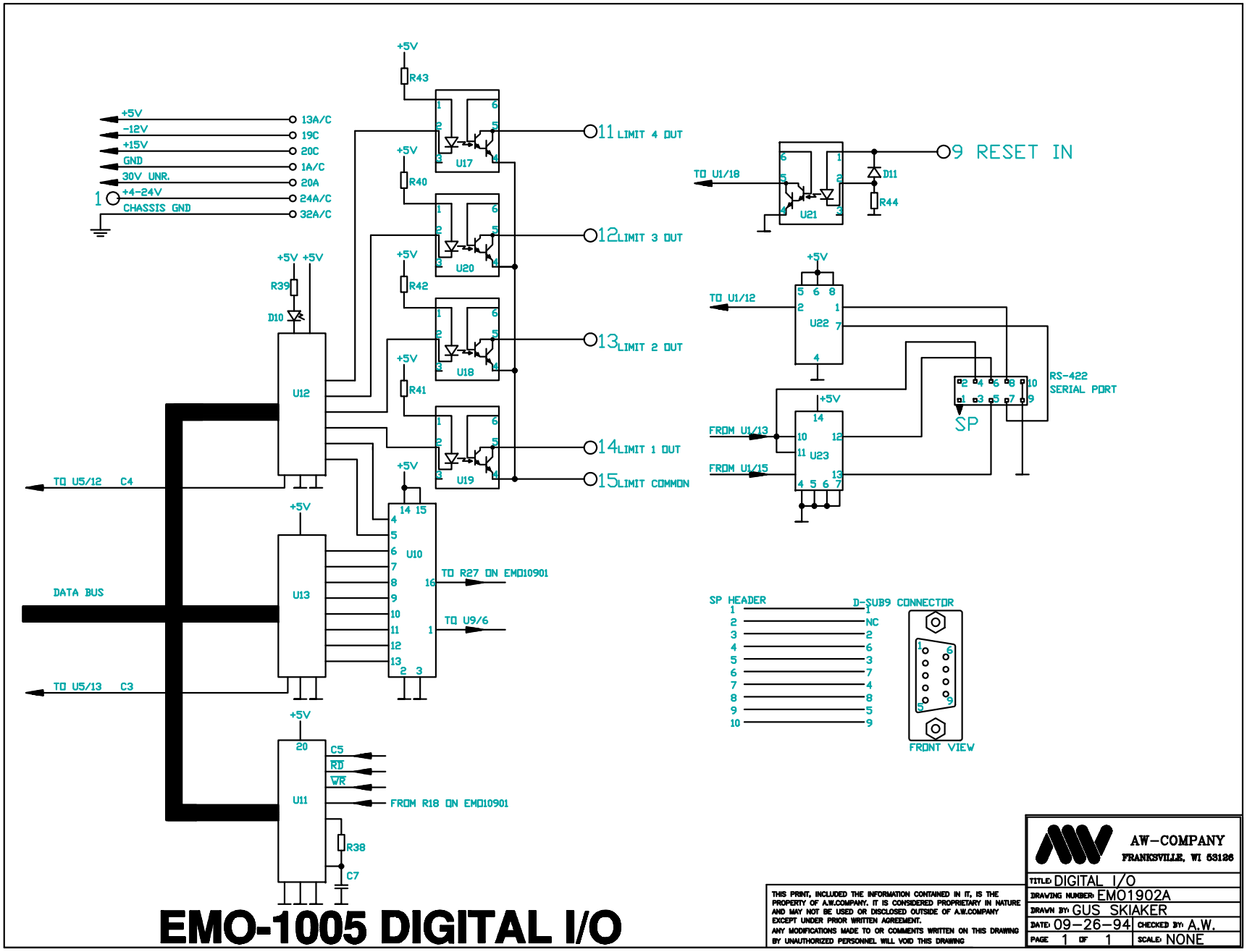
TITLE: DIGITAL & ANALOG I/O	
DRAWING NUMBER: EMO1901A	
DRAWN BY: GUS SKIAKER	
DATE: 09-26-94	CHECKED BY: A.W.
PAGE 1 OF 1	SCALE: NONE

APPENDIX D


+5V
-12V
+15V
GND
30V UNR.
+4-24V
CHASSIS GND
13A/C
19C
20C
1A/C
20A
24A/C
32A/C
R43
R40
R42
R41
U17
U20
U18
U19
11 LIMIT 4 OUT
12 LIMIT 3 OUT
13 LIMIT 2 OUT
14 LIMIT 1 OUT
15 LIMIT COMMON
R39
D10
U12
TO U5/12 C4
TO U5/13 C3
DATA BUS
U13
U10
TO R27 ON EMO10901
TO U9/6
U11
C5
RD
WR
FROM R18 ON EMO10901
R38
C7
TO U1/18
D11
R44
U21
9 RESET IN
TO U1/12
U22
RS-422
SERIAL PORT
SP
FROM U1/13
FROM U1/15
U23
SP HEADER
D-SUB9 CONNECTOR
NC
FRONT VIEW
EMO-1005 DIGITAL I/O
AW-COMPANY
FRANKSVILLE, WI 53126
TITLE: DIGITAL I/O
DRAWING NUMBER: EMO1902A
DRAWN BY: GUS SKIAKER
DATE: 09-26-94
CHECKED BY: A.W.
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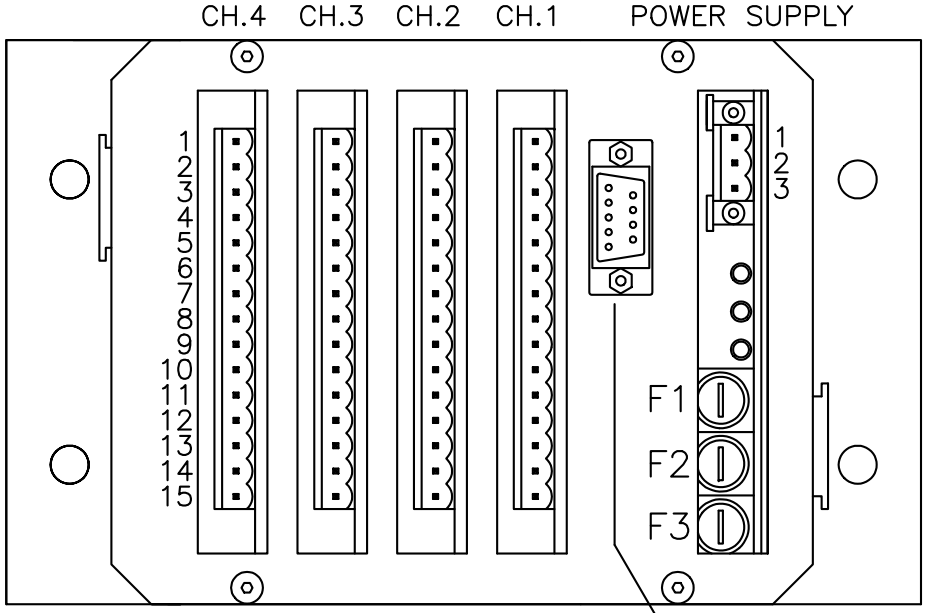
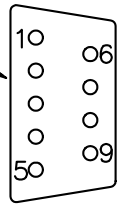
APPENDIX E



EMO-1005 REAR VIEW



SERIAL COMMUNICATION CONNECTOR:

RS-232 (OPTION)	PIN	RS-422 (STANDARD)
	1 –	
RS-232 RX	– 2 –	
RS-232 TX	– 3 –	RS-422(–) TRANSMIT
	4 –	RS-422(–) RECEIVE
GND	– 5 –	SIGNAL GROUND
	6 –	
	7 –	RS-422(+) TRANSMIT
	8 –	RS-422(+) RECEIVE
	9 –	SHIELD GROUND

CHANNEL CARD CONNECTIONS:

1 – + SUPPLY TO TRANSMITTERS
2 – INSTRUMENT GROUND
3 – NAMUR INPUT
4 – TRANSMITTER INPUT (FREQUENCY)
5 – ANALOG INPUT, 4–20mA (+)
6 – ANALOG INPUT, 4–20mA (–)
7 – ANALOG OUTPUT, 4–20mA (+)
8 – ANALOG OUTPUT, 4–20mA (–)
9 – RESET INPUT FOR TOTALIZER (3–24V)
10 – ANALOG OUTPUT, 0–5V/1–5V
11 – LIMIT 4 OUT
12 – LIMIT 3 OUT
13 – LIMIT 2 OUT
14 – LIMIT 1 OUT
15 – LIMITS COMMON

POWER SUPPLY CONNECTIONS:

1 – HOUSING GROUND
2 – NEUTRAL OR LIVE 110/220V 60/50HZ
3 – LIVE OR NEUTRAL 110/220V 60/50HZ

FUSES

F1 – 0.1A/250V AGC
F2 – 1A/250V AGC
F3 – 0.25A/250V AGC

EMO-1005 CONNECTIONS

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TITLE: EMO–1005 CONNECTIONS	
DRAWING NUMBER: EM01903A	
DRAWN BY: GUS SKIAKER	
DATE: 12–01–94	CHECKED BY: A.W.
PAGE 1 OF 1	SCALE: NONE

APPENDIX F

J10–J12

J10 – INPUT PIN 3 SENSIVITY 50mV
J11 – INPUT PIN 3 SENSIVITY 1.75V
J12 – INPUT PIN 3 SENSIVITY 3.75V

J14–J15

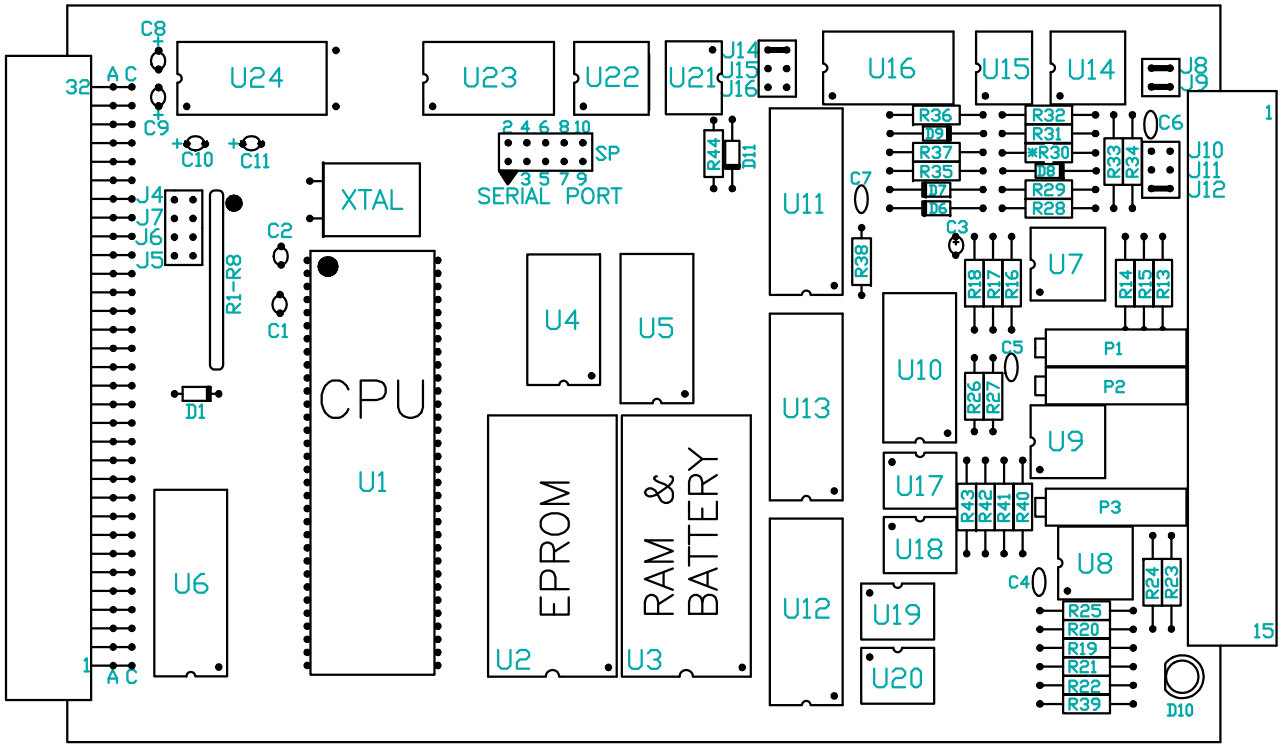
J14 – $F_{DISPLAY} = F_{IN} \times 1$
J15 – $F_{DISPLAY} = F_{IN} \times 0.5$
J16 – $F_{DISPLAY} = F_{IN} \times 0.25$

J8–J9

J8 AND J9 IN – PIN 2 GROUNDED
J8 ONLY – PIN 2 INSULATED FROM GROUND

J4–J7

DO NOT CHANGE



CHANNEL CARD JUMPERS

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TITLE: CH. CARD JUMPERS	
DRAWING NUMBER: EMO1904B	
DRAWN BY: GUS SKIAKER	
DATE: 03–22–95	CHECKED BY: A.W.
PAGE 1 OF 1	SCALE: NONE

APPENDIX G

SENSOR VOLTAGE ON PIN 1 – JM3

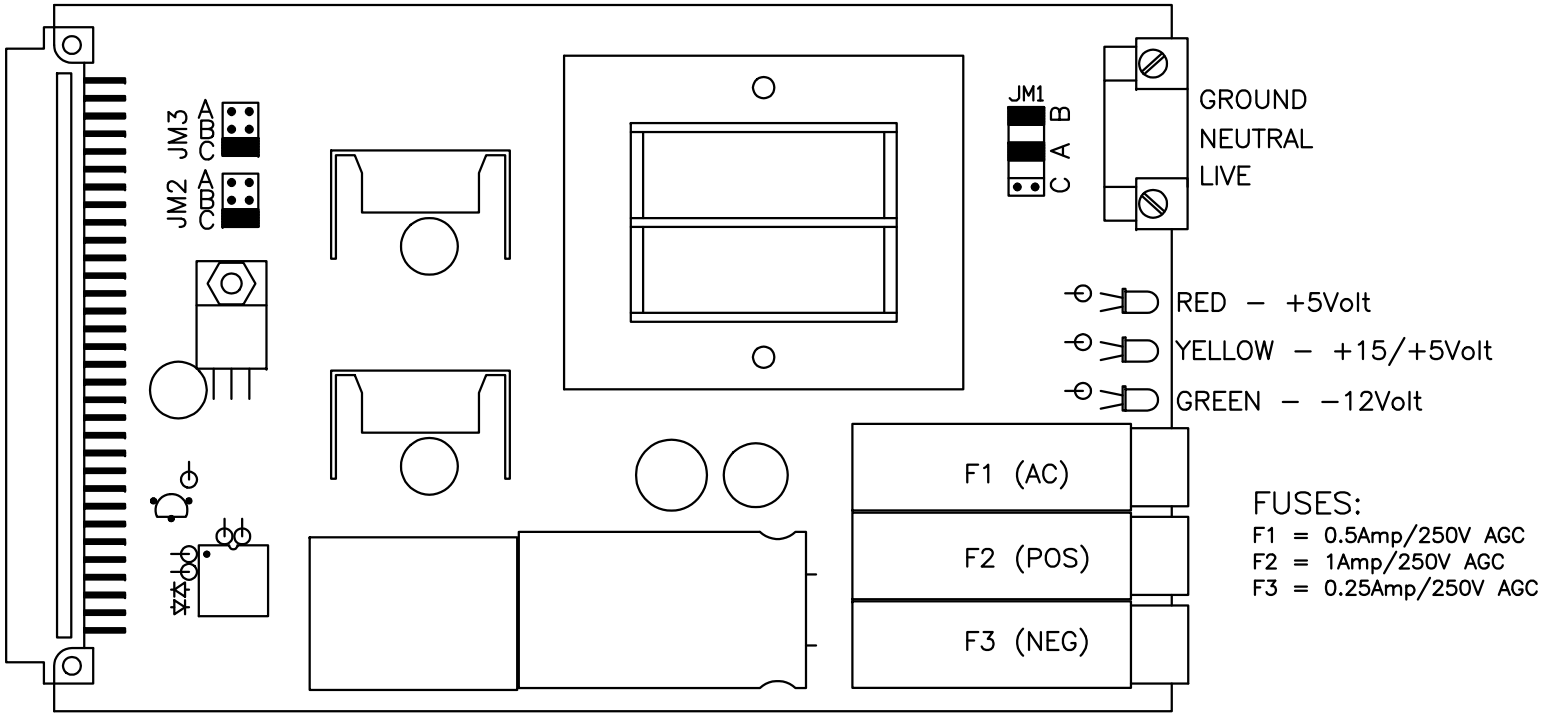
24Volt = A
15Volt = C <– DEFAULT
5Volt = B

ANALOG OUTPUT VOLTAGE – JM2

24Volt = C <– DEFAULT
15Volt = B
NONE = A

110V/220V (JM1)

110V = A & B <– DEFAULT
220V = C ONLY



FUSES:
F1 = 0.5Amp/250V AGC
F2 = 1Amp/250V AGC
F3 = 0.25Amp/250V AGC

POWER SUPPLY

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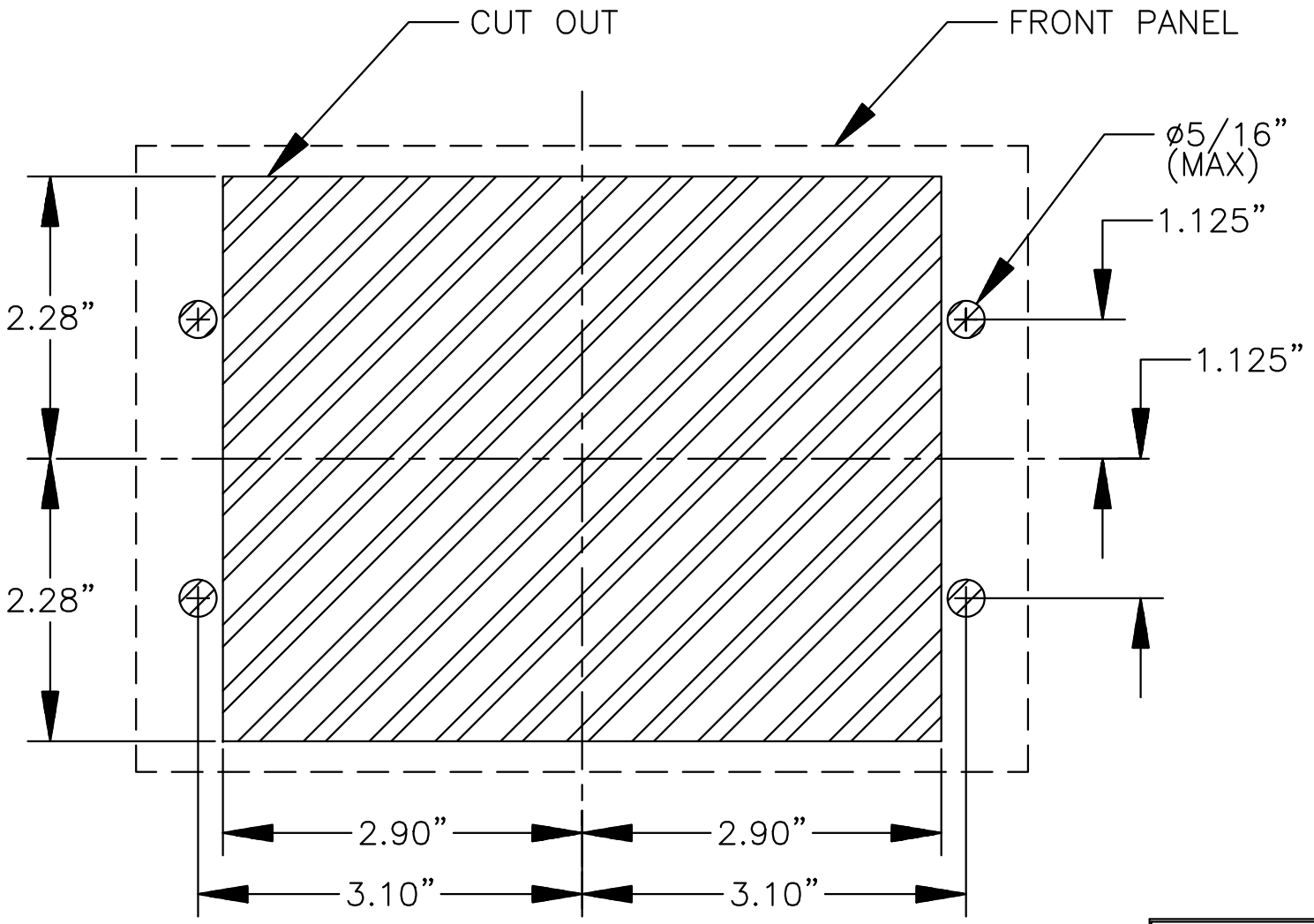
AW–COMPANY FRANKSVILLE, WI 53126	
TITLE: EMO POWER SUPPLY V4	
DRAWING NUMBER: EMO1912A	
DRAWN BY: GUS SKIAKER	
DATE: 09–26–94	CHECKED BY: A.W.
PAGE 1 OF 1	SCALE: NONE

APPENDIX H



PANEL CUTOUT

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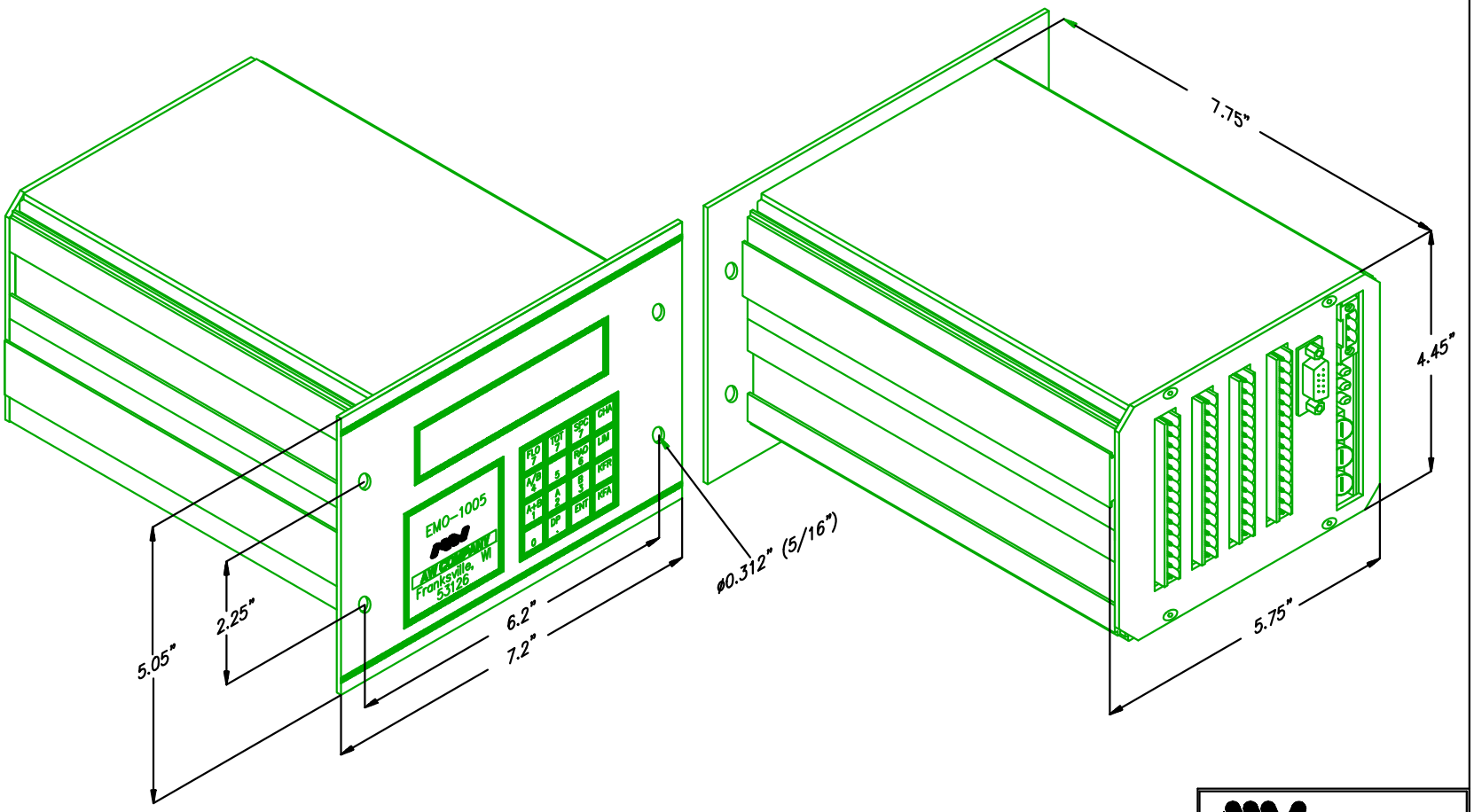
AW–COMPANY FRANKSVILLE, WI 53126	
TITLE: PANEL CUTOUT	
DRAWING NUMBER: EM01905A	
DRAWN BY: GUS SKIAKER	
DATE: 09–26–94	CHECKED BY: T.D.
PAGE 1 OF 1	SCALE: NONE

APPENDIX I



4 CH. UNIT DIMENSIONS

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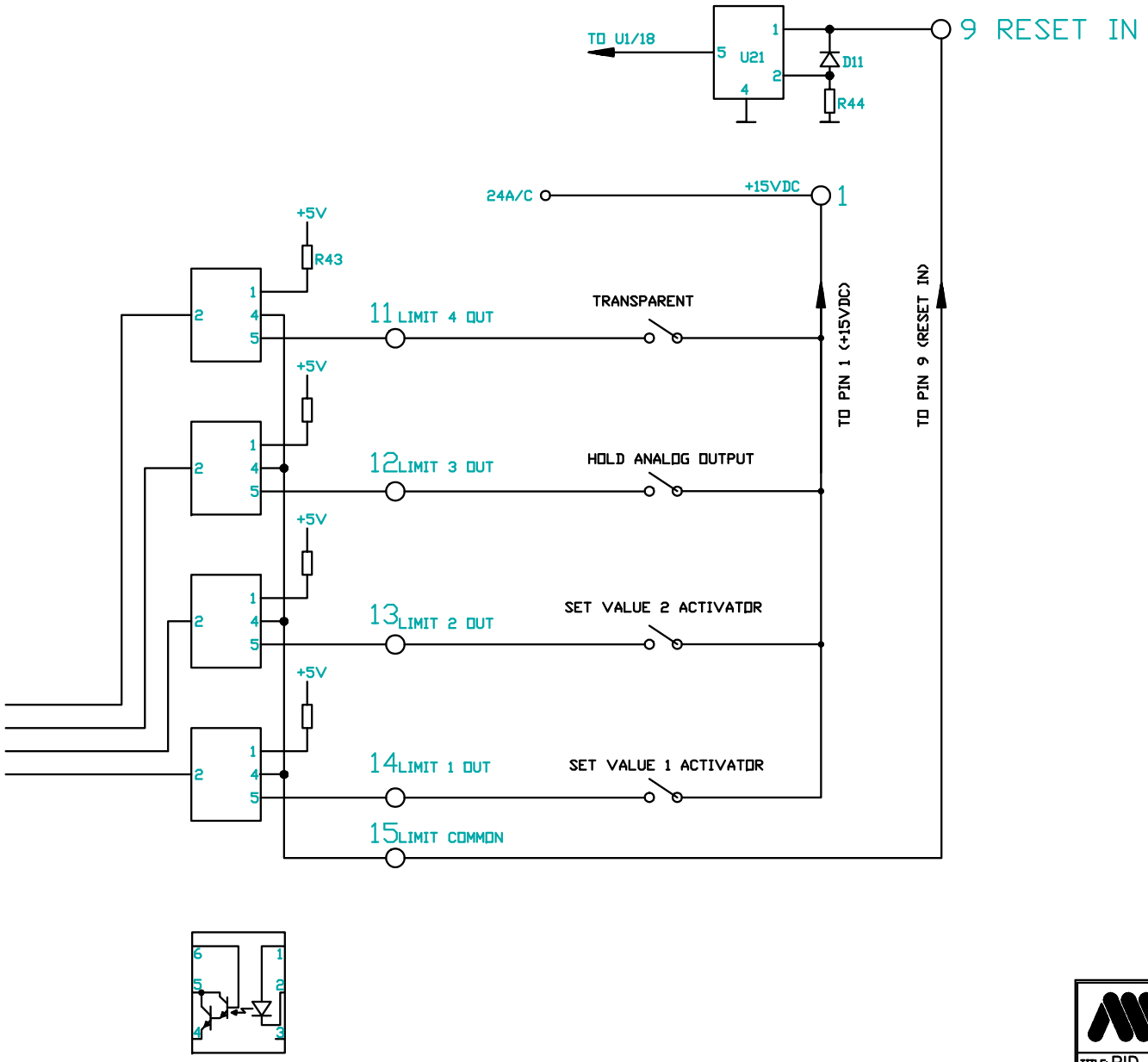
AW-COMPANY FRANKSVILLE, WI 53126	
TITLE: 4 CH. UNIT DIMENSIONS	
DRAWING NUMBER: EM01906A	
DRAWN BY: GUS SKIAKER	
DATE: 09-26-94	CHECKED BY: T.D.
PAGE 1 OF 1	SCALE: NONE

APPENDIX J



EMO-1005 HOOKUP IN PID MODE

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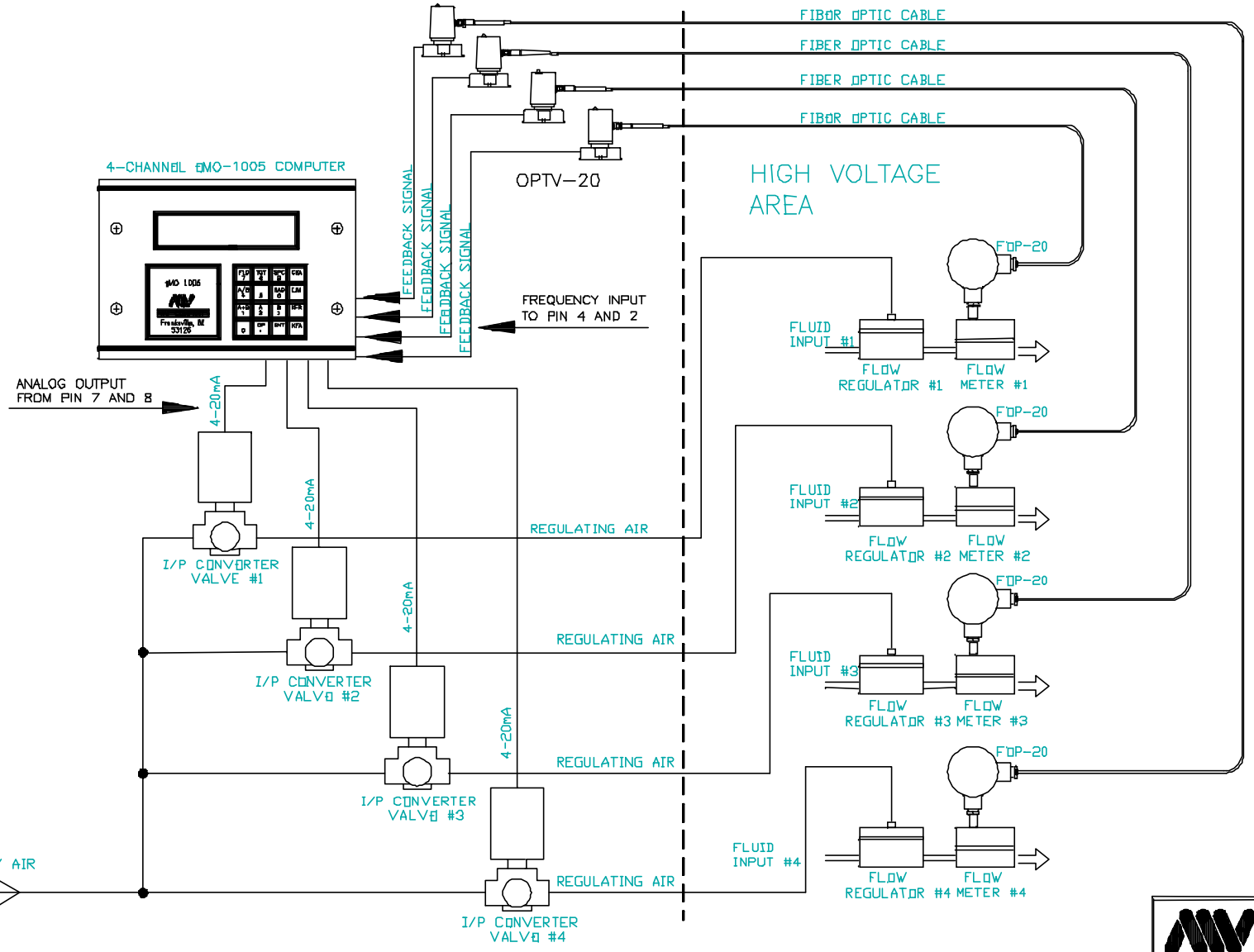
AW-COMPANY
FRANKSVILLE, WI 53126

TITLE: PID CONNECTIONS	
DRAWING NUMBER: EMO1907A	
DRAWN BY: GUS SKIAKER	
DATE: 09-26-94	CHECKED BY: A.W.
PAGE 1 OF 1	SCALE: NONE



FIBER OPTIC FLOW CONTROL SYSTEM

AW-COMPANY
FRANKSVILLE, WI 53126

TITLE: FLOW CONTROL SYSTEM	
DRAWING NUMBER: EMO1908A	
DRAWN BY: GUS SKIAKER	
DATE: 09-26-94	CHECKED BY: A.W.
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APPENDIX K

APPENDIX L: EMO-1005 WITH BUILT-IN PNAO

When the EMO-1005 is modified to have a built-in PNAO module, the following items need to be taken into consideration.

The PNAO modification allows the EMO-1005 to receive quadrature input flow-meter signals and provide a ± 5 volt output depending on flow direction. The voltage output is scaled using the KFA. When calculating the KFA, assume +5 volts for maximum forward flow over a flow range of 0-5 volts. When flow is reversed, the same KFA value is used to determine the zero to negative 5 volt scaling.

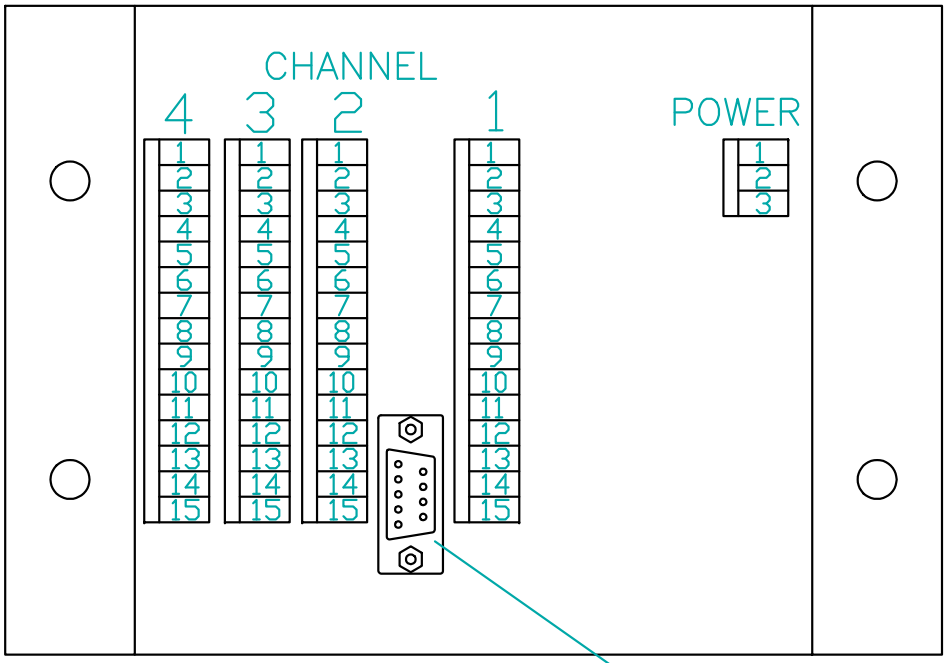
Pins 3 and 4 of the EMO-1005 receive the two frequency inputs, with pin 4 referred to as frequency A and pin 3 referred to as frequency B. If the PNAO output is opposite of what is desired, simply switch the connections to pins 3 and 4 on the EMO-1005.

The PNAO modifications do not affect the flow rate or totalization calculations of the EMO-1005. The flow rate displayed has no direction associated with it. For example, if the system is running 5 gpm in the reverse direction, the EMO-1005 will display 5 gpm, not -5 gpm. Furthermore, totals counted from flow in the reverse direction are added, not subtracted, to the various totalizers such as the current total and grand total.

It is recommended that the milli-amp output not be used on an EMO-1005 that has a built-in PNAO. This is because the modifications made for the PNAO alter the milli-amp circuitry somewhat.

EMO-1005 W/ BUILT-IN PNAO

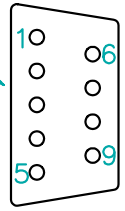
REV	DESCRIPTION	DATE



CHANNEL CARD CONNECTIONS:

1 – + SUPPLY TO TRANSMITTERS
2 – INSTRUMENT GROUND
3 – FREQUENCY B INPUT
4 – FREQUENCY A INPUT
5 – ANALOG INPUT, 4–20mA (+)
6 – ANALOG INPUT, 4–20mA (–)
7 – ANALOG OUTPUT, 4–20mA (+)
8 – ANALOG OUTPUT, 4–20mA (–)
9 – RESET INPUT FOR TOTALIZER (3–24V)
10 – ANALOG OUTPUT ±5VDC
11 – LIMIT 4 OUT
12 – LIMIT 3 OUT
13 – LIMIT 2 OUT
14 – LIMIT 1 OUT
15 – LIMITS COMMON

SERIAL COMMUNICATION CONNECTOR:



RS–232 (OPTION) PIN	RS–422 (STANDARD)
	1 – NO CONNECTION
RS–232 RX	2 – TTL LEVEL (FLOW CONTROL RECEIVE)
RS–232 TX	3 – RS–422(–) (FLOW CONTROL TRANSMIT)
	4 – RS–422(–) (FLOW CONTROL RECEIVE)
GND	5 – SHIELD GROUND
	6 – TTL LEVEL TX (FLOW CONTROL TRANSMIT)
	7 – RS–422(+) (FLOW CONTROL TRANSMIT)
	8 – RS–422(+) (FLOW CONTROL RECEIVE)
	9 – SIGNAL GROUND

POWER SUPPLY CONNECTIONS:

1 – HOUSING GROUND
2 – 110/220V AC
3 – 110/220V AC

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AW–COMPANY
RACINE, WI 53404

TITLE: EMO–1005 CONNECTIONS	
DRAWING NUMBER: EMO10304	
DRAWN BY: GUS SKIAKER	
DATE: 12–02–92	CHECKED BY: T.D.
PAGE 1 OF 1	SCALE: NONE

APPENDIX L