

# OPERATION OF ORIFICE METER CHART INTEGRATION

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## GENERAL

The EMC Chart Integrator, Model 362, is a digital computer based system for translating orifice meter chart records into accurate billing-compatible data on integrated flow (chart extension), average pressure and flow time. It is designed to accommodate American/Barton and Foxboro charts, as the pens can be mounted so as to pivot in the same geometric paths as the recording pens of these types of meters. As an option, the Chart Integrator can be fitted with pens for a third chart geometry if required. The operator places the Chart Integrator pens on the appropriate lines on the orifice chart while applying pressure to the foot control, the chart will begin to rotate. The rotation and motion of the pens simulate the action of the meter. At the end of the chart the Chart Integrator computes and prints the extension, pressure and flow time for that recording. The operator will then place the chart into the printer and the chart extension, average pressure, flow time and current date will be printed onto the back of the chart for validation. At chart validation the extension and the number of charts validated are recorded in the Chart Integrator's memory as a batch total. This batch total can be printed and cleared upon demand by the operator at any time.

## COMPONENT DESCRIPTION

The various components that comprise the Chart Integrator are described below:

1) **KEYBOARD** – The tactile sealed keyboard is located on the right side of the top plate on the Chart Integrator. It is divided into three sections. These sections are divided by color as well as system function. The top two rows of keys, (referred to as quick operation keys) are dark gray. The top row, labeled left to right, P LOW, P HIGH, H LOW, H HIGH, are quick calibration keys. These keys are offered as a method of re-calibrating a single point without performing a long calibration. Row two of the quick operation keys are defined as follows left to right.

**EXCESS:** If a chart is left on past its normal recording time, this key will allow the operator to integrate that extra flow and add it to the total reading of that chart. Under normal operation the chart integrator turn table will stop automatically after a full rotation of the chart. If EXCESS is pushed at any time before the full rotation is complete, the turn table will rotate until the operator stops and depressed the print key or the turn table makes an additional full rotation. Once the chart has been terminated by way of the print key or a second full

rotation, the excess will automatically turn off. The next chart integrated will stop automatically after a full rotation.

**CHART REPRINT:** If the operator inserts the integrated chart into the printer for validation and for some reason the information is not printed on the back of the chart, the operator would insert the chart back into the printer and depress this key. The chart information will be reprinted onto the chart without adding the information to the batch total in the battery backed ram.

**PRINT:** The operator will use this key to terminate the integration of a chart. If a chart has a partial recording of excess this key will be used.

**RESET:** In order to start the integration process the operator will depress this key.

The middle two rows of keys on the keyboard, (referred to as the operator function keys), are a light gray in color. They are labeled F1 through F6 with an up and down arrow on the far right of rows three and four. F1 through F6 can be defined by the operator or preset by the factory. This will be helpful to the operator for functions that are most frequently changed or in need of modification.

**UP ARROW AND DOWN ARROW:** The up and down arrows are used to scroll to a listed selection within a particular function code. Function codes and their option list are explained later.

The bottom four rows of the keyboard are basically arranged like a numeric calculator. They are white with numbers 0 through 9, decimal (.), minus(-), "E"(enter), "CE"(clear entry), "PD"(print define) and REVERSE(not operational). The operator will use this section of the keyboard to enter data, call functions and define parameters.

2) **LARGE DISPLAY** – This is a two line sixteen character LCD back-lite display. Its primary function is to display the Extension, Pressure and Time (E,P,T) at the end of the chart that is being integrated. Additionally, it is used to display a "Zero the Pens" message during power up and an "\*" between the words EXT. PRES. to indicate the computer port is active.

3) **SMALL DISPLAY** – This display is a four line sixteen character back-lite LCD. Its primary function is to provide a live interface with the operator and the chart processor functions. The top two lines of this display are used to display only the live value of the pressure and differential

pen positions in percent of scale, or as a backup for the extension, pressure and time on the large display by activating a specific function code. The bottom two lines of the small display are used for visual display of data entered from the keyboard.

4) **PRINTER** – The standard printer has 2<sup>1</sup>/<sub>4</sub>" wide paper detail tape and a slot cut in the side to insert the chart for chart validation. An optional flat bed printer can be attached to the integrator as well. This printer has no detail tape, however it has the ability to print up to 32 days of chart information directly on the back of the chart.

5) **MOTOR CONTROL BOARD** – The primary function of this board is to provide a regulated voltage from the foot control to the motor. It also provides a momentary reverse current break to stop the motor at the end of a chart rotation or when the foot control is released.

6) **MAIN CPU PROCESSOR BOARD** – This board is the heart of the chart integrator. It was specially designed to handle all of the functions of chart integration. The CPU board contains a multi-tasking processor, two RS232 full bi-directional ports, three digital outputs and four digital inputs.

7) **MECHANICAL ASSEMBLY** – This unit comprises the mechanics to integrate different pen geometries through HP optical encoders which are responsible for sending the pen location to the microprocessor for digitizing. The mechanical assembly is a precision hand machined geometrically correct assembly. It is all interconnected by way of steel cables routed through out. Counter balance weights have been engineered in the assembly to both pressure and differential assemblies to provide smooth flowing operation and enhance operator comfort.

## **CALIBRATION AND DAILY OPERATION**

Good accurate integration will depend a great deal on a good accurate calibration. Checks of this calibration should be performed two or three times during the course of a normal work day. The first stage of calibration is to give the microprocessor the encoders raw count at zero for a given chart geometry. This is accomplished at "power on" time when the integrator asks the operator to "Zero the pens." Once this completed the microprocessor stores this calibration pen information in battery back ram and should remain constant from day to day. When the chart integrator is turned on each day and a proper pen zeroing is performed, your calibration should be accurate and maintained from day to day.

During the course of daily operation the operator will want to perform minor checks of the integrator to assure accurate integration from chart to chart. These checks should include:

- A. Make sure the pen arms are secure and tight on their respective pen mounts.
- B. Check your calibration for accuracy.

## **FUNCTION CODE DESCRIPTION**

To address the microprocessor or configure the operation of your integration results, we have assigned what we refer to as function codes. These are two digit numeric entry's selected from the chart integrator keyboard. The function codes range from 01 through 99, however, we do not use all the numbers between this range. This is to allow new functions to be assigned to your program in a logical order. The function codes will fall into one of three categories:

- A. Display Only
- B. Numeric Entry Required
- C. Select From a Scroll List

To access a function within your chart integrator software, simply select the correct code on the keyboard. After you depress the appropriate function code number it will be displayed in the lower portion of the small display. If the function is other than a Display only code, you will then perform one of the following:

1. **Data entry codes:** Depress the "E" key, the cursor will begin to flash, enter the appropriate data, (if you miss enter the information depress the "CE" key, this will clear the current data for re-entry) depress the "E" key. The cursor will disappear and the display will be what you just entered.

2. **Scroll List codes:** Depress the "E" key, the cursor will begin to flash with the current scroll selection displayed. Use the UP or DOWN arrows on the keyboard to scroll through the list of selections. When your selection is displayed, depress the "E" key. The cursor will disappear and the display will be what you just selected.

Remember, after you call the function by entering the function code number, in order to change and accept data you **MUST** select the "E" key before and after the operation.

01–P & H PEN RAW VALUE: Display only the raw encoder counts for each pen. The readings should be 0 at the chart hub stop and below 4090 at the outer pen stops.

03–SQUARE ROOT H\*P: Display only the live square root of the H and P pen.

04–CALIBRATION: This is to initiate a cold start, long calibration.

05–ZERO THE PENS: Allows the operator to re-zero the pens without turning the chart integrator off and then on. Same as the power on start up procedure described previously.

06–P% & H% LIVE VALUE: Display only the live value of the pressure and differential pens.

10–CHART TYPE: Scroll list selection for the type of chart about to be integrated. For Barton (American), Foxboro, Honeywell simply select the correct type of chart. This

function has no bearing on the end results for the integration, it is strictly for printing a chart identifier on the back of the chart. EX: American would be AM, Foxboro FX, Honeywell HW.

11–NUMBER OF DAYS: Scroll list selection for the number of days in the rotation of the chart to provide automatic daily breakout and total for the chart.

12–EXCESS CHART: Scroll list selection for turning on excess for a batch of charts. The excess chart key is for one chart only and will turn off automatically, this function locks on and requires the operator to turn it off. Within this function you may select 1 or 7. This will allow the operator to break out the excess flow of a chart into 7 additional readings or lump the excess of a chart into one additional reading.

13–ATMOSPHERIC PRESSURE: Data entry of the atmospheric pressure for addition to the pressure reading for chart calculation. This entry is entered X100. EX: If your atmospheric pressure is 14.65, it is entered 1465.

14–PRESSURE RANGE: Data entry automatically called if function 13 is entered. This is the pressure range of the chart being integrated. Enter the full scale range of the chart in PSI.

19–BATCH TOTAL: Allows the operator to call up the total number of charts and the total extensions of the charts integrated as well as print this information and clear the total.

20–PRINT CURRENT INTEGRATOR SETTINGS: This FC will cause the printer to list the variables of the operating mode of the chart integrator such as: Type of chart, number of days excess, etc. This should be done whenever the chart integrator is set up prior to running charts in insure proper configuration.

22–INDEPENDENT PENS: Scroll list selection. Normal chart integration is extension, pressure and time displayed in this function as E,P & T. Other options are P & T or H & T. This function is used to integrate temperature and gravity charts when only one pen integration and print are required. If H & T mode is selected the large display will change to DIFF TIME, if the P & T mode is selected the large display will change to PRESS TIME. This lets the operator know that only one pen is active during this integration.

24–LINEAR AVERAGE: Scroll list selection, P PEN, H PEN, BOTH PENS, NONE. If this function is turned on for any of the selections, the readings will not be extended over time. Normally, in the case of a partial chart, the pressure and differential would be averaged over 800 time counts, even though flow only occurred over part of the chart. This will lower the overall reading as the pressure and differential is assumed to be zero over the remainder of the 800 time counts. In order to attain a average reading of either pen or both during actual flow time, “Linear Average” would be activated.

The linear average function will be used for temperature and gravity charts and in some instances for orifice charts if your host volume program is expecting a pressure reading not extended over time.

31–INTEGRATOR COUNTS: Scroll selection, (yes, no). If you select yes then the Extension of the chart will be multiplied by .5367. This is useful to offices that have flow calculations set up for the old type integrators.

32–PERCENT TIME: Scroll selection, (yes, no). If yes the time count of the chart for full rotation will be 1000 instead of 800. When this is done, the time counts will directly represent the percent of total chart rotation during which flow occurred. EX: 913 time counts would equal 91.3%.

33–REVERSE PENS: Scroll selection (P,H,BOTH, NONE). This function is used if you have a chart with the pen zero reversed. Instead of zero at the chart hub, it is at the outer edge of the chart.

35–AVERAGE SQUARE ROOT P PEN: Scroll selection (yes, no). This will provide the average square root of the pressure pen for the integrated results, This reading is not extended over time. This function would be used for L10 or square root charts.

36–ROOT OF THE P PEN: Scroll selection (yes, no). This is the same as function code 35 with the exception that the end pressure result is extended over time.

37–P MAXIMUM E.U.: Data entry. The E.U. stands for engineering units. This function would be used in conjunction with function code 22 Independent Pens (P pen). If you were integrating a temperature or gravity chart with the pressure pen you would enter the maximum range of this chart in the function to obtain an end result in actual degrees of specific gravity units respectively.

38–H MAXIMUM E.U.: Data entry. The same as function code 37 only using the differential pen for the integration.

40–PRINT MODE: Scroll selection. (NONE, DETAIL, SUMMARY, BUFFERED).

- a. NONE: Turns the print to the printer off.
- b. DETAIL: Prints daily break information at the end of chart.
- c. SUMMARY: Prints only the total of a chart, not the daily.
- d. BUFFERED: Prints the detail information as you integrate the chart, (this is the normal mode).

41–COMMUNICATIONS MODE: Scroll selection. (NONE, DETAIL, SUMMARY).

- a. NONE: No chart information is sent out the communications port.
- b. DETAIL: All daily information is sent out the communications port.
- c. SUMMARY: Only the total of the chart is sent out the communications port.

50-DISPLAY EXT, PRESS, TIME: Display only. This is a back up for the large display. If selected it will be displayed in upper portion of the small display. You would use this function code of the large display ever malfunctioned.

60-HOST COMPUTER: Scroll selection. (On, Off) This activates the computer port. A "\*" in the large display located between EXT and PRESS will turned on to provide the operator with a visual indication.

61-LEGEND: Data entry. If you enter an identifier (number only) in this function it will be transmitted out the communications port.

62-START DATE: Data entry. (YYMMDD). If you enter the start date of the chart it will be transmitted out the communications port.

63-START TIME: Data entry. (HHMM). If you enter the start time of the chart it will be transmitted out the communications port.

64-MACHINE NUMBER: Data entry. This is used to distinguish one chart integrator from another. If you this function it will only print the machine number on the back of the chart.

65-OPERATOR NUMBER: Data entry. Same as function code 64 only used to distinguish between different operators.

66-TEMPERATURE: Data entry. If you enter a temperature in this function it will be transmitted out the computer port.

84-P PEN OFFSET: Data entry. This function would be used to add a percentage of offset to the pressure pen for chart calculation. This function is used for integrating a chart that has been removed from a meter that was in error in the field.

85-H PEN OFFSET: Data entry. This function operates the same as function code 84 only for the differential pen.

99-TIME AND DATE DISPLAY: Data entry and display. When the chart integrator is started up you will enter the current date and time. This will hold for the life of the integrator. When the current date and time is entered, the date will be printed on the back of the chart during chart validation.

In summary, the above function codes are designed to enhance the operation of the chart integrating process. As new function codes are added, a new quick reference function code table with a brief explanation of how they operate can be provided.

## MAINTENANCE

In order to ensure maximum accuracy and reliability from the chart integrator, some periodic checks and adjustments are necessary to be made by the operator. These can be divided into two groups: Daily and Weekly.

### Daily

1) Prior to calibrating, check the pens for proper arc. The differential pen should follow the arc line on a chart from 100% to 0%. Adjust if necessary. With the differential pen adjusted properly, check the pressure pen. It should lag the differential pen by exactly 15 minutes at the zero percent line on a single day chart.

2) Check the pen stops. Move the pens through their entire range. Both pens should go from approximately 1-2% below zero to 110% of chart. Adjust if necessary.

3) Prior to calibrating, check for tightness of pen mounting thumbscrews. Also check for any "play" or slippage between pen and trace handle.

### Weekly

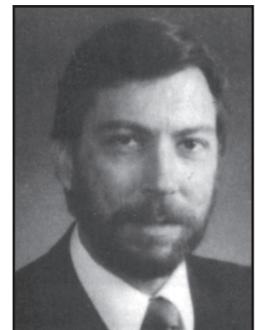
1) Check the turntable for smooth operation. If any vibration or hesitation is noted repair as necessary.

2) Check the turntable tightness. Grasp the table and turn it by hand. The turntable should move freely with only a slight amount of resistance. If no resistance or excessive resistance is noted, adjustment and/or repairs must be made by a qualified technician.

3) Clean air filters. Clogged air filters can cause excessive heat to build inside the integrator.

## SUMMARY

When properly maintained and operated, the chart integrator can provide reliable chart integration for many years. The overall accuracy of the integration process will be determined by the proficiency of the operator as well as the upkeep and calibration of the chart integrator.



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