Appendix A
Flow Meters

The Evolution DX2 series controller provides a variety of user-configurable, flow-related features for either one or two flow sensors, referred to as Flow #1 and Flow #2.

The Evolution DX2 flow features/capabilities include:

- Display of instantaneous flow rate in gallons per minute (GPM) for Flow #1, Flow #2 and total (Flow #1 + Flow #2). Flow rates are updated every ten seconds.
- Display of monthly flow accumulations in gallons for Flow #1, Flow #2 and total (Flow #1 + Flow #2). Flow accumulation in gallons is updated every minute.
- Automatic termination of watering based upon flow limit violations:
    - Main line flow rate for controller (GPM)
    - Maximum flow rate per station (GPM)
    - Minimum flow rate per station (GPM)
    - Maximum flow accumulation per month (gallons)
    - Unscheduled flow rate for controller (GPM)
- Automatic condemnation and reporting of stations violating flow limits. Warning information is provided in the Field Maintenance Activity and Troubleshooting section of the manual.
- Automatic establishment of station upper and lower flow limits (learn mode).

Flow Meter Operation Overview

In order to display flow rate and/or flow accumulation data:

a. Insure flow sensor/meter has been properly connected Refer to Flow Sensor Installation Instructions

b. Establish the appropriate flow calibration criteria, see "Flow Meter Offset and K Values

In order to establish flow limit checking either on a controller or individual station basis, verify the following:

c. Steps a and b (above) have been performed.

d. Station Upper Limits have been established, see "Max Flow Limit".

e. Station Lower Limits have been established, see "Flow Limit" page or "Auto Limits".

f. Main flow limits have been established, (see "Main Flow".

g. Total Monthly Flow has been set, see "Flow Options".

h. Unscheduled Flow Limit has been defined; see "Unscheduled Flow Limit".

i. The upper and lower limit checking is enabled; see "Enable/Disable Limit Checking".

j. The appropriate flow limit check delay has been established, see "Delay Limit".

k. Selection of either one or two flow meters, see "Flow Meter Compare Limits".

Flow Reading Accuracy

Since the Evolution DX2 controller has been designed to work directly with flow sensors, the accuracy of the actual readings are limited only by the flow sensor devices. Typical accuracy values are approximately 1%.

Flow Meter Offset and K Values

Each flow meter installation must include entry of the "offset" value and "K" values for proper calibration of the meter. Use the following table to determine the appropriate values for your installation.

Table 3: Calibration Table

Tee Mounted Sensors – Flow Sensors

RAIN MASTER FLOW SENSORS SELECTION CHART

FLOW SENSOR MODEL NO.	PIPE CONNECTION SIZE	SUGGESTED OPERATING RANGE	**MAXIMUM WATER PRESSURE**	**K VALUE**	**OFFSET VALUE**	**BODY MATERIAL**	CONNECTION TYPE
FS-B100	**1 Inch**	**2-40 GPM**	**400 PSI**	**109**	**27**	**Bronze**	NPT female
FS-B125	**1 ¼ Inch**	**3-60 GPM**	**400 PSI**	**209**	**32**	**Bronze**	NPT female
FS-B150	**1 ½ Inch**	**4-80 GPM**	**400 PSI**	**291**	**24**	**Bronze**	NPT female
FS-B200	**2 Inch**	**10-100 GPM**	**200 PSI**	**750**	**0**	**Bronze**	NPT female with copper male adapters
FS-B250	**2 ½ Inch**	**16-160 GPM**	**200 PSI**	**1021**	**370**	**Bronze**	NPT female
FS-150	**1 ½ Inch**	**5-100 GPM**	**100 PSI @ 68º F**	**457**	**0**	**PVC**	Slip
FS-200	**2 Inch**	**10-200 GPM**	**100 PSI @ 68º F**	**776**	**104**	**PVC**	Slip
FS-300	**3 Inch**	**20-300 GPM**	**100 PSI @ 68º F**	**2268**	**483**	**PVC**	Slip
FS-400	**4 Inch**	**40-500 GPM**	**100 PSI @ 68º F**	**3752**	**834**	**PVC**	Slip
FS-INSERT-B	**3 to 40 Inches**	**Varies, Call Factory**	**400 PSI**	**See attached table RMIS Part No. 500712**		Requires pipe saddle with 2 Inch female NPT	

Data Industrial Tee Mounted Sensors

Complete calibration tables for Tee mounted sensors are listed at the end of this appendix.

Flow Limit Checking

To perform limit checking, the controller computes a Gallon-Per-Minute (GPM) flow rate based upon the total gallons used in the previous 60 seconds.

Limit checks are then performed on the following:

- Station upper limit
- Station lower limit
- Main flow limit
- Total monthly flow limit
- Unscheduled flow limit

Each station limit can be automatically established by the controller or manually entered.

Details about each limit are given below.

Warning:

Limit checking is only performed when either the upper and/or lower limits have been ENABLED.

Station Upper Limit

Enter an upper flow limit for the station, as described in Chapter 4. The controller compares the flow meter reading to the station limit. If the meter value is larger than the limit, an error condition is detected.

The suggested upper limit flow rate should be set to the nominal flow rate for the station + 20%.
The system default value for upper station limit is 500 GPM.
Obtain the nominal flow rate from the controller display (see Chapter 7, for the steps in displaying flow rate). You should allow adequate "settling time" for the flow meter readings before obtaining the nominal flow rate.
Upper station limits should be increased, if water pressure varies greatly.

Station Lower Limit

Enter a lower flow limit for the station, as described in Chapter 4. The controller compares the flow meter reading to the station limit. If the meter value is less than the limit, an error condition is detected.
To detect a mis-adjusted valve or clogged line, enter a relatively small (but non-zero) lower limit.
The system default value for lower station limit is 0 (zero) GPM.

Main Flow Limits

Enter the Main Flow Limit, as described in the Main Flow procedure in Chapter 4. The controller compares the flow meter reading to controller/main line station limit. If the meter value is greater than the limit, an error condition is detected.

The system default value for controller/main line limits is 2000 GPM.

The Main Flow upper limit should be set higher than the total of all simultaneously "on" stations. However, this limit should be lower than the anticipated flow rate from a main line break.
In Flow Max systems, the total water consumption of all participating controllers is calculated into the Main Flow limit.

Total Monthly Flow Limit

Enter a maximum monthly flow limit, as described in Chapter 4. The controller compares the accumulated monthly flow to maximum monthly flow limit. If the accumulated flow is greater than the limit, an error condition is detected.
The system default value for maximum monthly total is NONE. When NONE is selected, no monthly flow checking is performed.

If the monthly limit is exceeded, there are two options available, STOP WATERING and GIVE WARNING. See Chapter 4: Setup for details on selecting each option.
The system default is: GIVE WARNING.
If the stop watering option is selected, the problem is reported in the warning list and watering stops.

Watering is restarted when:

- The limit is changed to a larger value
- The limit is changed to None
- A new month begins

If the Give Warning option is selected, a warning is reported in the warning list and watering continues.

Unscheduled Flow Limit

Unscheduled Flow Limit is defined as any water flow that is not programmed or under the control of the controller. If a water flow is greater than the limit and no stations are on, the controller will shut down the water supply until the condition is corrected.
Unscheduled Flow conditions may be due to broken water lines, defective valves, faulty solenoids and etc.

The Unscheduled Flow procedure is given in the Controller Setup section of Chapter 4. The default limit is 200 GPM.

Enabling and Disabling Flow Limit Checking

Once the station limits have been established, the flow limit checking (upper and lower limits) may be enabled or disabled. When upper limits have been enabled, all station upper limits as well as the monthly water limit will be validated. When lower limits have been enabled, all station lower limits will be validated on an individual station basis. See Chapter 4 for the steps to enable or disable station flow limit checking.

The default setting for limit checking is DISABLED for all stations.

When they are disabled, no limit checking is performed. However, the GPM flow and total monthly flow readings are unaffected.

Delaying Flow Rate Limit Checking

Due to drainage of water lines, the initial flow rate for a station may be much higher than the station steady state condition. To prevent erroneous station fault detections, the controller delays a period of time after a station is turned on before making flow rate limit checks. This delay may be set from 1 to 6 minutes. The system default for delay of limit checking is two (2) minutes.
To establish the proper delay, monitor the GPM flow rate for each station in the irrigation program (s).

See Chapter 7 for details on monitoring GPM rates.

Observe which station takes the longest time for its GPM rate to "settle." Round this time period to the next minute and use this rounded value as the flow rate limit check delay.

Warning:

This delay value establishes the amount of time in which a main or station line break can be detected and subsequently shutdown.

Limit Checking with Two Flow Meters

When two flow meters are used, you may select which meter is used for limit checking. Alternately, you may check the total flow from both meters.

See Chapter 4: Setup for details.

Flow Meter Reading

Procedure

To observe flow meter readings, from the base menu:

Step 1 Advance to the Measurements Options screen as follows:

```
F1=Main Menu
F3=Status
F2=Measurements
```

```
| F1 | =FLOW        | F2 | =CURRENT
| F3 | =MOISTURE | F4 | =ET  | F5 | =RAIN/WIND | ↑ |
```

Figure 175: Measurement Options

Step 2 Select F1=FLOW METER.
The meter flow readings for Flow #1 and Flow #2 are shown in Gallons-Per-Minute. Readings are updated every 10 seconds.

Figure 176: Flow Meter Readings

Reading Monthly Water Totals

Procedure

To read the monthly water totals, from the base menu:

Step 1 Advance to the Status Options screen as follows:

```
F1=Main Menu
F3=Status
```

```
| F1 | =COMM STATUS      | F2 | =MEASUREMENTS
| F3 | =WATER TOTAL      | F4 | =REVIEW ALL   | ↑ |
```

Figure 177: Status Options

Step 2 Select F3=WATER TOTAL then select F1=TOTALS PAST MONTH.

```
FLOW #1  PAST  G = 600          TOTAL GPM=900
FLOW #2  PAST  G = 300                  | ↑ |
```

Figure 178: Water Total

The past month total gallons for Flow #1 and Flow #2 are shown.

Step 3 Select F2=TOTALS PRESENT MONTH. The total present month gallons for Flow #1 and Flow #2 are shown.
To update the totals, press the Up Arrow key and select F2 again.

When a Flow Limit Violation is Detected

Upon detection of a flow limit violation, Evolution DX2 performs the following actions:

1. Terminate Irrigation
    - For a faulty station, immediate termination of irrigation for that station. The program will automatically advance to the next station in the program.
    - If a main line fault is detected, immediate termination of all irrigation programs. The Normally Open (N.O.) Master Valve terminal is energized with 24 VAC. Any and all future automatic irrigation will not occur until this warning is cleared from the controller.
    - If the monthly watering allocation has been exceeded, immediate termination of all irrigation on a per program basis occurs.
    - If an unscheduled flow condition is detected, the Normally Open (N.O.) Master Valve terminal is energized with 24 VAC. Any and all future automatic irrigation will not occur until this warning is cleared from the controller.
2. Entry of the problem in the Warning/Report list.
3. All faulty stations are added to a "condemned" station list. No watering will occur until the problem is corrected.

To remove a station from the condemned list, delete the problem entry from the warning report, see Chapter 10.

Flow Limit Violation Examples

Overflow in Controller/Main Line Break

Assume the maximum controller flow rate is 500 GPM. A main line break occurs while attempting to water station 7. The break results in a flow of 750 GPM. The following warning message is displayed, as well as the station number and GPM reading.

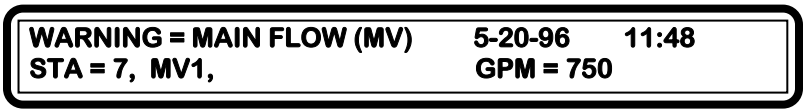


Figure 179: Warning, Main Flow

The MV1 in the second line represents the Master Valve #1. To access the warning report, from the base menu, press F2=WARNING.

Note: Break between Flow Sensor and First Station.

Assume that a line breaks between the flow sensor and the first valve. When the break occurs, no watering will take place. The following entry would be placed in the warning list.

Figure 180: Warning, Unsched Limit

Note: This situation may also be caused by a valve that fails to close.

Station Overflow

Assume station 2 has an upper limit of 300 GPM. A broken line occurs, resulting in a 400 GPM flow. The following entry is placed in the warning list.

Figure 181: Warning, Flow Up Limit

Station Under Flow

Assume station 2 has a lower limit of 100 GPM. The line to station 2 is clogged, resulting in a flow reading of 53 GPM. The following entry is placed in the warning list.

Figure 182: Warning, Flow Low Limit

Monthly Water Limit Exceeded

The controller has exceeded its monthly watering allocation. The Water Limit message is placed in the warning list.

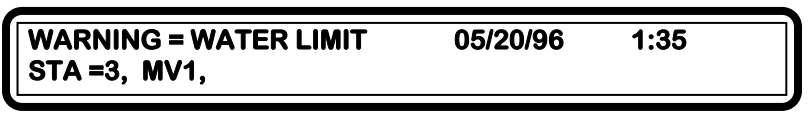


Figure 183: Warning, Water Limit

This problem **cannot** be cleared from the report until the water limit is set to a higher value or until a new month begins.

Multiple Stations with Non-Overlap Protection

The Evolution DX2 controller allows the user the capability of turning "on" several stations simultaneously. When flow meters are used in this environment, the individual station limits are summed and compared to the total flow rate. Therefore, you must set up limits for each station to insure that flow limit checks are performed properly.

> **Example:**
> Assume the upper limit for station 1 is 80 GPM and the upper limit for station 2 is 50 GPM. If both stations are on, the controller adds these limits. A problem is reported if the flow exceeds the total of 130 GPM (80 GPM + 50 GPM).

Table 4: Rain Master K and Offset Value

Rain Master K and Offset Value For Data Industrial Flow Sensors

CALIBRATION TABLE – TEE MOUNTED SENSORS (Current Production) Models) (Series: 228PV, 228 BR, 228 CB, 228 CS, 228SS, 250BR)

Data Industrial Model	Apparent ID	Evolution Satellite K Value	Evolution Satellite Offset	Min Design Flow (GPM)	Max Design Flow (GPM)
228PV-1.5	1.50	457	0	5	100
228PV-2	1.94	776	104	10	200
228PV-3	4.02	2268	483	20	300
228PV-4	5.15	3752	834	40	500
228BR-2	1.99	750	0	10	100
228BR-2.5	2.52	1021	370	16	160
228CB-2	2.07	777	199	12	120
150 PSI Tee	2.07	777	199	12	120
400 PSI Tee	2.10	711	167	12	120
228CB-2.5	2.51	1021	265	16	160
228CS-2	2.07	767	199	12	120
228SS-2	1.99	750	0	10	100
250BR-0.5	None	92	8	0.8	8
250BR-0.75	None	119	64	1	10
250BR-1	1.05	109	27	2	40
250BR-1.25	1.38	209	32	3	60
250BR-1.5	1.61	291	24	4	80

OBSOLETE OR OLDER MODEL FLOW SENSORS

(Series: 220P, 228B, 228CB, 250B, 228PF, 228PD, 228CS, 228SS, *IR220P, IR228B, IR228CB, IR250B, IR228CS, IR228SS)

Data Industrial Model	Apparent ID	Evolution Satellite K Value	Evolution Satellite Offset	Min Design Flow (GPM)	Max Design Flow (GPM)	Minimum Recommended Full Scale (GPM)
220P-1	0.96/FM-92D	70	25	2	20	5
220P-1.5	1.50/FM-92D	505	107	8	180	40
220P-2	194/FM-92D	744	273	13	250	50
220P-3	4.02/Any	2268	483	35	700	160
220P-4A	5.15/Any	4191	975	65	1200	300
220P-6A						
228PD-1	0.96/FM-92D	70	26	2	20	5
228PD-1.5	1.50/FM-92D	505	107	8	180	40
228PD-2	1.94/FM-92D	744	273	13	250	50
228PF-1.5	1.71	569	279			
228PF-2	2.21	1075	185			
228PF-3	2.98	1512	841			
228PF-4	2.99	2814	1911			
228PF-6A						
228B-2	1.99/FM-92D	750	0	10	250	50
228B-2.5	2.52	1022	370	16	400	75
228CB-2	2.07/FM-92D	767	198	12	250	50
150 PSI Tee	2.07/FM-93A					
400 PSI Tee	2.10/FM-91D	711	167	12	250	50
228CB-2.5	2.51	1021	265	16	400	75
228CS-2	2.07/FM-92D, FM-93A	767	198	12	250	50
228SS-2	1.99/FM-92D	750	0	10	250	50
250B-1	1.05/FM-93A	113	47	2	45	8
250B-1.25	1.38/FM-93A	209	32	3	90	15
250B-1.5	1.61/FM-93A	291	24	4	100	20

Rain Master K and Offset Value For Data Industrial Flow Sensors

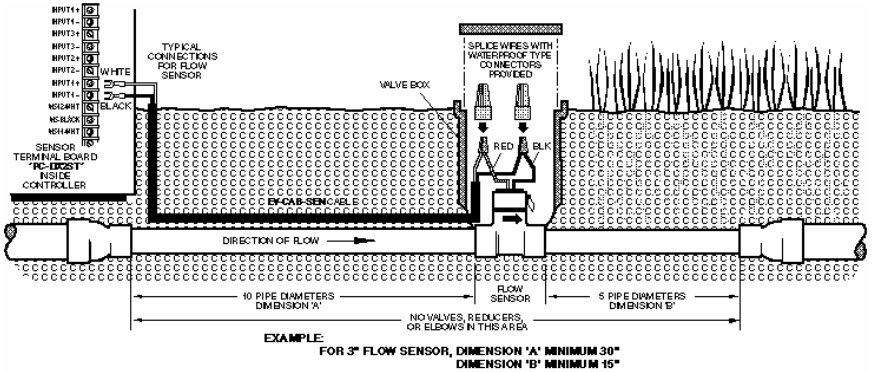
Pipe Size	Pipe O.D. in Inches	Pipe I.D. in Inches	Evolution Satellite K Value	Evolution Satellite Offset	Min. Flow in GPM	Min. Flow in GPM for Full Scale
3 inch Sch 10S	3.5	3.260	1368	115	12	400
Std. Wt. Sch 40	3.5	3.068	1191	70	12	400
Ex. Strong Sch 80	3.5	2.900	1053	42	12	400
PVC Class 125	3.5	3.284	1391	121	12	400
PVC Class 160	3.5	3.230	1338	107	12	400
PVC Class 200	3.5	3.166	1278	91	12	400
4 inch Sch 10S	4.5	4.260	2620	592	20	600
Std. Wt. Sch 40	4.5	4.026	2277	489	20	600
Ex. Strong Sch 80	4.5	3.826	2008	354	20	600
PVC Class 125	4.5	4.224	2565	577	20	600
PVC Class 160	4.5	4.072	2361	554	20	600
PVC Class 200	4.5	4.072	2342	525	20	600
5 inch 10S	5.563	5.295	4451	1044	30	900
Std. Wt. Sch 40	5.50	5.047	4006	932	30	900
Ex. Strong Sch 80	5.50	4.813	3594	829	30	900
6 inch 10S	6.625	6.357	6576	1603	50	1500
Std. Wt. Sch 40	6.5	6.065	5890	1419	50	1500
Ex. Strong Sch 80	6.5	5.761	5312	1265	50	1500
PVC Class 125	6.625	6.217	6239	1509	50	1500
PVC Class 160	6.625	6.115	5997	1445	50	1500
PVC Class 200	6.625	5.993	5752	1381	50	1500
8 inch Sch 10S	8.625	8.329	11989	3215	80	2500
Sch 20	8.625	8.125	11371	3018	80	2500
Sch 30	8.625	8.071	11210	2975	80	2500
Std. Wt. Sch 40	8.625	7.981	10943	2884	80	2500
Sch 60	8.625	7.813	10453	2735	80	2500
Ex. Strong Sch 80	8.625	7.625	9914	2566	80	2500
PVC Class 125	8.625	8.095	11281	2994	80	2500
PVC Class 160	8.625	7.961	10884	2868	80	2500
PVC Class 200	8.625	7.805	10429	2729	80	2500

Rain Master K and Offset Value For Data Industrial Flow Sensors

Pipe Size	Pipe O.D. in Inches	Pipe I.D. in Inches	Evolution Satellite K Value	Evolution Satellite Offset	Min. Flow in GPM	Min. Flow in GPM for Full Scale
10 inch Sch 10S	10.75	10.420	19163	5768	125	4000
Sch 20	10.75	10.250	18473	5509	125	4000
Sch 30	10.75	10.136	18037	5345	125	4000
Std. Wt. Sch 40	10.75	10.020	17622	5187	125	4000
Ex. Strong Sch 60	10.75	9.750	16657	4827	125	4000
Sch 80	10.75	9.564	16010	4594	125	4000
PVC Class 125	10.75	10.088	17863	5276	125	4000
PVC Class 160	10.75	9.924	17273	5054	125	4000
PVC Class 200	10.75	9.728	16580	4804	125	4000
12 inch 10S	12.75	12.390	28566	9831	175	5000
Sch 20	12.75	12.250	27997	9556	175	5000
Sch 30	12.75	12.090	27122	9156	175	5000
Std. Wt. Sch 40S	12.75	12.000	26638	8943	175	5000
Sch 40	12.75	11.938	26309	8783	175	5000
Sch 60	12.75	11.625	24690	8057	175	5000
Extra Strong	12.74	11.750	25328	8336	175	5000
Sch 80	12.75	11.376	23457	7523	175	5000
PVC Class 125	12.75	11.966	26457	8857	175	5000
PVC Class 160	12.75	11.770	25430	8394	175	5000
PVC Class 200	12.75	11.538	24254	7869	175	5000
14 inch 10S	14.00	13.500	33390	12242	200	6000
Sch 20	14.00	13.375	32819	11941	200	6000
Std. Wt. Sch 30	14.00	13.250	32255	11645	200	6000
Sch 40	14.00	13.124	31694	11353	200	6000
Sch 60	14.00	12.814	30343	10699	200	6000
Extra Strong	14.00	13.00	31149	9639	200	6000
Sch 80	14.00	12.50	29027	10041	200	6000

Rain Master K and Offset Value For Data Industrial Flow Sensors

Pipe Size	Pipe O.D. in Inches	Pipe I.D. in Inches	Evolution Satellite K Value	Evolution Satellite Offset	Min. Flow in GPM	Min. Flow in GPM for Full Scale
16 inch 10S	16.00	15.500	43473	17937	300	9000
Sch 20	16.00	15.375	42791	17495	300	9000
Std. Wt. Sch 30	16.00	15.250	42115	17100	300	9000
Ex. Strong Sch 40	16.00	15.000	40785	16331	300	9000
Sch 60	16.00	14.688	39163	15388	300	9000
Sch 80	16.00	14.314	37278	14332	300	9000
18 inch Sch 10S	18.00	17.500	55348	25847	350	10000
Sch 20	18.00	17.375	54553	25271	350	10000
Sch 30	18.00	17.124	52979	24145	350	10000
Std. Wt.	18.00	17.250	53765	24705	350	10000
Sch 40	18.00	16.876	51451	23110	350	10000
Sch 60	18.00	16.500	49187	21632	350	10000
Extra Strong	18.00	17.000	52211	23599	350	10000
Sch 80	18.00	16.126	46997	20140	350	10000



Upon completion of the physical installation of the flow sensor, complete the wiring connection from the flow sensor to the DX2 controller by following the procedure below.

1. **TURN THE POWER OFF AT THE CONTROLLER**
2. At the Flow Sensor:
   Connect the **BLACK** wire of the Flow Sensor to the **BLACK** wire of the "**EV-CAB-SEN**", sensor cable.
   Connect the **RED** wire of the Flow Sensor to the **WHITE** wire of the "**EV-CAB-SEN**", sensor cable.
   *Use the weatherproof connectors provided with the Flow Sensor to make the splice.
3. At the controller:
   Connect **BLACK** wire of "**EV-CAB-SEN**" to "**INPUT 1-**" of the SENSOR TERMINAL BOARD (**PC-DX2ST**).
   Connect **WHITE** wire of "**EV-CAB-SEN**" to "**INPUT 1+**" of the SENSOR TERMINAL BOARD (**PC-DX2ST**).
4. Turn **POWER ON** at the Controller.
5. Set the Rain Master "K" and "OFFSET" values for the Flow Sensor at the controller based on the type and size of the Flow Sensor installed.

REFER TO THE TABLE PROVIDED WITH THE FLOW SENSOR FOR CORRECT "K" AND "OFFSET" FOR YOUR APPLICATION.

DWG FS10A

Figure 184: Flow Sensor Installation