QS200
POWER CONSUMPTION

This document provides an explanation of power consumption and the tools to quickly and efficiently calculate QS200 power usage.

DOWNLOAD QS200 POWER CONSUMPTION CALCULATOR @ http://bit.ly/flomec-qs200-pc

Power consumption is illustrated in the diagram below (see Figure 1 – Please note that this diagram simplifies the micro-circuitry but is a good model for power consumption).

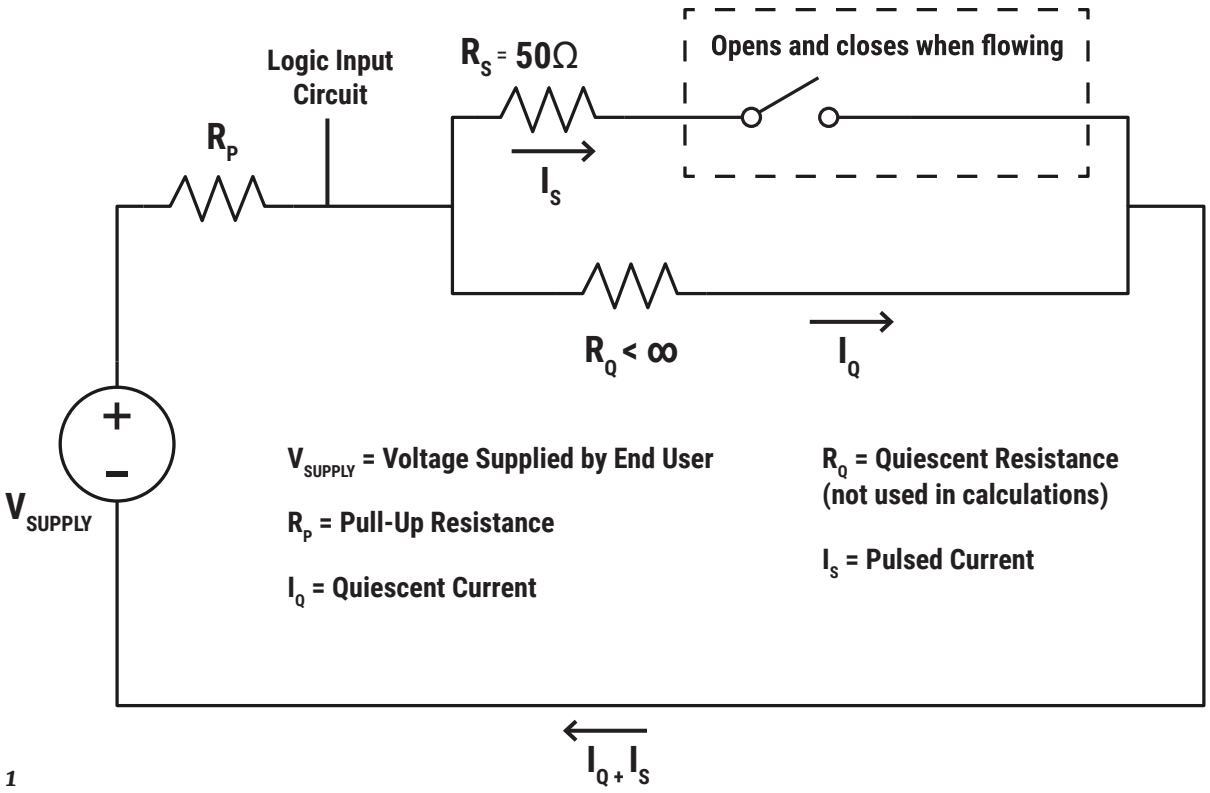

Figure 1

It will be assumed that the Quiescent resistance (R_Q) is significantly greater than the pull-up resistor (R_P). This is another simplification (without compromising the accuracy of the power calculation). Thus, negligible voltage drop will not be taken into consideration and will simply calculate constant power (power that is always consumed by the QS200 meter) as:

Constant Power = Vsupply*Quiescent Current =

Vsupply*I_Q = Vsupply*(.0002 Amps) = Constant Power

I_Q = Quiescent Current = .0002 Amps = 0.2 mA

Vsupply = Voltage Supplied by End user (in the range of 7.5 V_{DC} to 36 V_{DC}).

However, there is also the "pulse rate power" that must be taken into consideration. The pulse is related to frequency of the sensor. The frequency is also determined by the flow rate of the QS200 (higher flow rate means higher frequency which means greater power consumption). Flow rate related to frequency is displayed below for informative purposes (see Figure 2). The QS200 Power Consumption Calculator (referred to as "calculator" in the rest of this white paper) will internally take care of Figure 2 values. Note that these values came from QS200 Data Sheet.

FLOW INSERT SELECTION CHART

Flowmeter Model	Pipe Size	Operating Range (Min.)	Operating Range (Max.)	Maximum Water Pressure***	FLOMEC Tee K-Factor (Freq)*	Non-FLOMEC Tee K-Factor (Freq)*	Offset Value**	Meter Material	Adapter Material	Tee Material	Process Port
QS200-10	1 in.	0.22 GPM (0.83 L/min) 0.1 ft/sec	33 GPM (124.92 L/min) 15 ft/sec	150 psi @ 73°F (10 bar @ 23°C)	0.5386	N/A	0	Ryton	-	PVC	Slip
QS200-15	1.5 in.	0.55 GPM (2.08 L/min) 0.1 ft/sec	82 GPM (310.41 L/min) 15 ft/sec	150 psi @ 73°F (10 bar @ 23°C)	0.7926	0.7947	0	Ryton	-	PVC	Slip
QS200-20	2 in.	0.92 GPM (3.48 L/min) 0.1 ft/sec	138 GPM (522.39 L/min) 15 ft/sec	150 psi @ 73°F (10 bar @ 23°C)	1.3765	1.3583	0	Ryton	-	PVC	Slip
QS200-30	3 in.	2.06 GPM (7.80 L/min) 0.1 ft/sec	309 GPM (1169.70 L/min) 15 ft/sec	150 psi @ 73°F (10 bar @ 23°C)	3.8444	4.2505	0	Ryton	PVC	PVC	Slip
QS200-40	4 in.	3.58 GPM (13.55 L/min) 0.1 ft/sec	537 GPM (2032.78 L/min) 15 ft/sec	150 psi @ 73°F (10 bar @ 23°C)	7.1676	7.2229	0	Ryton	PVC	PVC	Slip
QS200	*Insert only*			150 psi @ 73°F (10 bar @ 23°C)	use pipe size to determine value	use pipe size to determine value	0	Ryton	PVC	N/A	N/A

Figure 2

**K and offset values are used to calculate the frequency of the pulses from the QS200 electronics*
The formula for frequency is Freq = (GPM/K) - offset
*** Offsets listed in this table are expected to be calibrated at the factory and therefore no additional correction should be required.*
**** Maximum water pressure for larger line sizes would be based on the material of the sensor, adapter, and pipe. Pressure is also derated due to temperature (1.20 psi / °F).*

- **Pulse Current = $V_{supply}/(R_s + R_p)$**
- **Pulse Power (instant maximum) = $(V_{supply})^2/(R_s + R_p)$**
- Vsupply = Voltage Supplied by End user (in the range of 7.5 V_{DC} to 36 V_{DC}).
- R_S = Sensor Resistance = 50 ohms
- R_P = pull-up resistance (depends on end user application and use)

NOTE: End user should do the following to find reasonable R_p value for irrigation controller (or similar):

1. With an ohmmeter – measure open circuit voltage on the controller's flowmeter input
2. With an ammeter – measure the short circuit current on controller's flowmeter input (connecting ammeter across the flowmeter input)

- R_P = Open Circuit Voltage/Short Circuit Current
- This is a very good estimate that is not usually available for controllers. ***NOTE: Check values for each input since the values and manufacturing variance/tolerance information tends to not be readily available.***

Since the pulse current will only run at 50% of time maximum (Frequency of 111 HZ which is greater than any of the Maximum GPM flow Operating Range → the pulse can only be generated for a maximum of 4.5 mS and must be off for another 4.5 mS → the fastest cycle is 4.5 mS off and 4.5 mS on = 9 mS → Theoretical Max frequency = 1/(9 mS) = 111 Hz), a quick maximum average power usage can be calculated as:

- **Maximum Average Power Consumption of Meter = 0.5*(Pulse Power) + Constant Power**
- **Maximum Current (instant Maximum) = Pulse Current + I_Q = Pulse Current + .0002 Amps**

Example A (full calculation)

End user wants to use a 15 V_{DC} supply with a sensor resistance (R_P) of 4700 ohms. The end user wants to know the power consumption of the flowmeter's minimum, maximum, and 200 GPM flow rates (4 inch pipe size application & FLOMEC® Tee will be used). What are the power consumption values at these specified flow rates? What is the instant maximum current (or peak current) that will go through this meter at any time?

1. Meter parameters that do not change:

- R_S = 50 ohms (always – meter parameter)
- I_Q = .0002 Amps (always – meter parameter)

2. End user's parameters that depend on end user's application:

- In this case the end user has V_{supply} = 15 V_{DC}
- End user has a pull-up Resistance of R_P = 4700 ohms
- Maximum GPM = 537 GPM = 537 GPM/7.1676 – 0 = Frequency of 74.92 HZ (values and calculations come from Figure 2)
- Minimum GPM = 3.58/7.1676 – 0 = Frequency of 0.4995 HZ (See Figure 2)
- 200 GPM = 200/7.1676 – 0 = 27.90 HZ (See Figure 2)

3. End user makes calculations:

- **Constant Power (0 HZ) = V_{supply}*I_Q = V_{supply}*(.0002 Amps) = 15 V*.0002 A = .003 W**
- **Pulse Power (instant maximum) = $(V_{supply})^2/(R_S + R_P)$ = $(15\ V)^2/(50\ ohms + 4700\ ohms)$ = .04737 W**
- **Maximum Current (instant Maximum) = $V_{supply}/(R_S + R_P) + I_Q$ = (15 V)/(50 ohms + 4700 ohms) + .0002 A = .003358 Amps – Answer to Maximum or peak current**
- **Maximum Average Power Consumption of Meter (111 HZ) = 0.5*(Pulse Power) + Constant Power = 0.5*(.04737 W)+.003 W = .026685 Watts**

The simple Y = M*X+B can be used to find different flow rates.

Y = .003 W = (M)*0 + B = B = .003 W

M = Rise/Run = (.5*Pulse Power (Instant Maximum))/111 Hz = .5*(.04737 W)/111 Hz = 2.13378 X 10^{-4} W Per HZ

Check at 0 HZ = Y = (2.13378 X 10^{-4} W Per HZ)*(0 HZ) + .003 W = .003W = checked

Check at 111 HZ Y = (2.13378 X 10^{-4} W Per HZ)*(111 HZ) + .003 W = .026685 W = Checked

Don't worry – The calculator will calculate the values (just an example).

Calculations for Average Power Consumption for Maximum, Minimum, and 200 GPM are listed below:

- Maximum GPM (74.92 HZ) = (2.13378 X 10^{-4} W Per HZ)*(74.92 HZ) + .003 W = .018986 Watts
- Minimum GPM (.4995 HZ) = (2.13378 X 10^{-4} W Per HZ)*(0.4995 HZ) + .003 W = .003107 Watts
- 200 GPM (27.90 HZ) = (2.13378 X 10^{-4} W Per HZ)*(27.90 HZ) + .003 W = .008953 Watt

Example B (Using Tool – but calculating Rp manually)

End user wants to know Minimum Current, maximum (peak current), Minimum and Maximum Average Power Consumption (4 inch pipe & FLOMEC® Tee will be used):

1. End user has measured: Open Circuit Voltage & Short Circuit Current.

- Open Circuit Voltage = 13.6 V_{DC}
- Short Circuit Current = 3.25 mA = .00325 A
- R_P = 13.6 V_{DC}/.00325 A = 4184.6 ohms

2. End user uses the calculator to find out power/current consumption.

- The following is known
- -Voltage (Open Circuit Voltage)
- -R_p (just calculated)
- -Pipe Size

3. The end user enters these values beside the blue entries of the calculator as directed (see Figure 3).

QS200 Meter	Numerical Value (values must be greater than zero - check parameters entered if values are < or = to 0)	Units
Min Theoretical average Power Consumption - 0 HZ	0.00272	Watts
Max Theoretical average Power Consumption - 111 HZ	0.024559135	Watts
Pulse Power (Instant Maximum)	0.043678269	Watts
Max GPM	537	GPM
Max Frequency GPM (HZ)	74.92047547	HZ
Min GPM	3.58	GPM
Min Frequency GPM (HZ)	0.499469836	HZ
Customer desired GPM (between Max and Min GPM)	False Check Param	GPM
Custermer disired GPM Frequency (HZ)	False Check Param	HZ
Pipe Size in INCHES (Choose 1, 1.5, 2, 3, or 4)	4	INCHES
K-Factor	7.1676	
		Units
Maximum or Peak Current (Amps)	False Check Param	AMPS
Minimum Average Power Consumption in Watts (@ Min GPM value)	False Check Param	Watts
Maximum Average Power Consumption in Watts (@ Max GPM Value)	False Check Param	Watts
Customer desired GPM (between Max and Min GPM) Average Power Consumption in Watts	False Check Param	Watts
Customer Parameters (Enter Values in blank Cells right of this spreadsheet)	Enter Values Below	Units
Pipe Size in INCHES (Choose 1, 1.5, 2, 3, or 4)	4	INCHES
Vsupply (Volts) - Must Be between 7.5 - 36 V (DC)	13.6	Volts (DC)
Pull-up resistance (R_p) Ohms	4184.6	Ohms
Customer desired flow rate GPM (Must be between min and max flow rate as specified in data sheet)		GPM
Tee K-Factor (Select Tee You Are Using) ◉ FLOMEC Tee K-Factor (Freq) ○ NON-FLOMEC Tee K-Factor (Freq)		
Note: Minimum Current = Quiescent Current = .0002 A = .2 mA		Units

Choose K-Factor type here

Figure 3

Example B (Using Tool – but calculating Rp manually) continued

After the previous steps, the end user is not getting the values they want. However they see the Minimum and Maximum required flow rates. The end user then enters 300 for the GPM value (the range is between 3.58 and 537 GPM - see Figure 4). Now they can find the answers.

QS200 Meter	Numerical Value (values must be greater than zero - check parameters entered if values are < or = to 0)	Units
Min Theoretical average Power Consumption - 0 HZ	0.00272	Watts
Max Theoretical average Power Consumption - 111 HZ	0.024559135	Watts
Pulse Power (Instant Maximum)	0.043678269	Watts
Max GPM	537	GPM
Max Frequency GPM (HZ)	74.92047547	HZ
Min GPM	3.58	GPM
Min Frequency GPM (HZ)	0.499469836	HZ
Customer desired GPM (between Max and Min GPM)	300	GPM
Custermer disired GPM Frequency (HZ)	41.85501423	HZ
Pipe Size in INCHES (Choose 1, 1.5, 2, 3, or 4)	4	INCHES
K-Factor	7.1676	
		Units
Maximum or Peak Current (Amps)	0.003411637	AMPS
Minimum Average Power Consumption in Watts (@ Min GPM value)	0.00281827	Watts
Maximum Average Power Consumption in Watts (@ Max GPM Value)	0.017460526	Watts
Customer desired GPM (between Max and Min GPM) Average Power Consumption in Watts	0.010954931	Watts
Customer Parameters (Enter Values in blank Cells right of this spreadsheet)	Enter Values Below	Units
Pipe Size in INCHES (Choose 1, 1.5, 2, 3, or 4)	4	INCHES
Vsupply (Volts) - Must Be between 7.5 - 36 V (DC)	13.6	Volts (DC)
Pull-up resistance (R_p) Ohms	4184.6	Ohms
Customer desired flow rate GPM (Must be between min and max flow rate as specified in data sheet)	300	GPM
Tee K-Factor (Select Tee You Are Using) ◉ FLOMEC Tee K-Factor (Freq) ○ NON-FLOMEC Tee K-Factor (Freq)		
Note: Minimum Current = Quiescent Current = .0002 A = .2 mA		Units

Choose K-Factor type here

Figure 4

- Minimum Current = Quiescent Current = .0002 A = .2 mA
- Maximum (peak current) = .003412 A = 3.412 mA
- Minimum Average Power Consumption = .00281827 W = 2.81827 mW
- Maximum Average Power Consumption = .0174605 W = 17.4605 mW

Example C (2 inch pipe)

Known values

- 25.5 mA @ 23.28 V_{DC}
- Open Circuit Voltage = 23.28 V_{DC}
- Short Circuit Current = 25.5 mA = .0255 A
- Pipe size = 2 inch
- FLOMEC® Tee will be used (select FLOMEC Tee K-factor [Freq] - see below)

1. Enter known values into calculator to find pull-up resistance.
2. Enter rounded pull-up resistance, Pipe size and Vsupply (Open Circuit Voltage) into calculator.
3. Enter 100 GPM (or other desired value between MIN. and MAX. GPM range) into calculator.
4. Look at desired parameters.

QS200 Meter	Numerical Value (values must be greater than zero - check parameters entered if values are < or = to 0)	Units
Min Theoretical average Power Consumption - 0 HZ	0.004656	Watts
Max Theoretical average Power Consumption - 111 HZ	0.286064187	Watts
Pulse Power (Instant Maximum)	0.562816375	Watts
Max GPM	138	GPM
Max Frequency GPM (HZ)	100.2542681	HZ
Min GPM	0.92	GPM
Min Frequency GPM (HZ)	0.668361787	HZ
Customer desired GPM (between Max and Min GPM)	100	GPM
Custermer disired GPM Frequency (HZ)	72.64802034	HZ
Pipe Size in INCHES (Choose 1, 1.5, 2, 3, or 4)	2	INCHES
K-Factor	1.3765	

		Units
Maximum or Peak Current (Amps)	0.024375961	AMPS
Minimum Average Power Consumption in Watts (@ Min GPM value)	0.006350437	Watts
Maximum Average Power Consumption in Watts (@ Max GPM Value)	0.258821512	Watts
Customer desired GPM (between Max and Min GPM) Average Power Consumption in Watts	0.188833907	Watts

Desired Parameters

Customer Parameters (Enter Values in blank Cells right of this spreadsheet)	Enter Values Below	Units
Pipe Size in INCHES (Choose 1, 1.5, 2, 3, or 4)	2	INCHES
Vsupply (Volts) - Must Be between 7.5 - 36 V (DC)	23.28	Volts (DC)
Pull-up resistance (R_p) Ohms	912.94	Ohms
Customer desired flow rate GPM (Must be between min and max flow rate as specified in data sheet)	100	GPM

Tee K-Factor (Select Tee You Are Using)
- (•) FLOMEC Tee K-Factor (Freq)
- ( ) NON-FLOMEC Tee K-Factor (Freq)

Choose K-Factor type here

Note: Minimum Current = Quiescent Current = .0002 A = .2 mA

		Units
Pull-up Resistance Calculator	912.9411765	Ohms
Open Circuit Voltage (With an ohmmeter - measure open circuit voltage on the controller's flow meter input)	23.28	Volts
Short Circuit Current (With an ammeter – measure the short circuit current on controller's flow meter input - connecting ammeter across the flow meter input)	0.0255	Amps

Figure 5

Example D (1 inch pipe)

Known values

- 5.1 mA @ 13.8 V_{DC}
- Open Circuit Voltage = 13.8 V_{DC}
- Short Circuit Current = 5.1 mA = .0051 A
- Pipe size = 1 inch
- FLOMEC® Tee will be used (select FLOMEC Tee K-factor [Freq] - see below)

1. Enter known values into calculator to find pull-up resistance.
2. Enter rounded pull-up resistance, Pipe size and Vsupply (Open Circuit Voltage) into calculator.
3. Enter 20 GPM (or other desired value between MIN. and MAX. GPM range) into calculator.
4. Look at desired parameters.

QS200 Meter	Numerical Value (values must be greater than zero - check parameters entered if values are < or = to 0)	Units
Min Theoretical average Power Consumption - 0 HZ	0.00276	Watts
Max Theoretical average Power Consumption - 111 HZ	0.037311577	Watts
Pulse Power (Instant Maximum)	0.069103154	Watts
Max GPM	33	GPM
Max Frequency GPM (HZ)	61.26995915	HZ
Min GPM	0.22	GPM
Min Frequency GPM (HZ)	0.408466394	HZ
Customer desired GPM (between Max and Min GPM)	20	GPM
Custermer disired GPM Frequency (HZ)	37.13330858	HZ
Pipe Size in INCHES (Choose 1, 1.5, 2, 3, or 4)	1	INCHES
K-Factor	0.5386	

		Units
Maximum or Peak Current (Amps)	0.005207475	AMPS
Minimum Average Power Consumption in Watts (@ Min GPM value)	0.002887146	Watts
Maximum Average Power Consumption in Watts (@ Max GPM Value)	0.021831835	Watts
Customer desired GPM (between Max and Min GPM) Average Power Consumption in Watts	0.014318688	Watts

Desired Parameters

Customer Parameters (Enter Values in blank Cells right of this spreadsheet)	Enter Values Below	Units
Pipe Size in INCHES (Choose 1, 1.5, 2, 3, or 4)	1	INCHES
Vsupply (Volts) - Must Be between 7.5 - 36 V (DC)	13.8	Volts (DC)
Pull-up resistance (R_p) Ohms	2705.88	Ohms
Customer desired flow rate GPM (Must be between min and max flow rate as specified in data sheet)	20	GPM
Tee K-Factor (Select Tee You Are Using) ◉ FLOMEC Tee K-Factor (Freq) ○ NON-FLOMEC Tee K-Factor (Freq)		

Choose K-Factor type here

Note: Minimum Current = Quiescent Current = .0002 A = .2 mA

		Units
Pull-up Resistance Calculator	2705.882353	Ohms
Open Circuit Voltage (With an ohmmeter - measure open circuit voltage on the controller's flow meter input)	13.8	Volts
Short Circuit Current (With an ammeter – measure the short circuit current on controller's flow meter input - connecting ammeter across the flow meter input)	0.0051	Amps

Figure 6

Example E (1-½ inch pipe)

Known values

- 3.5 mA @ 31.2 V_{DC}
- Open Circuit Voltage = 31.2 V_{DC}
- Short Circuit Current = 3.5 mA = .0035 A
- Pipe size = 1.5 inch
- FLOMEC® Tee will be used (select FLOMEC Tee K-factor [Freq] - see below)

1. Enter known values into calculator to find pull-up resistance.
2. Enter rounded pull-up resistance, Pipe size and Vsupply (Open Circuit Voltage) into calculator.
3. Enter 20 GPM (or other desired value between MIN. and MAX. GPM range) into calculator.
4. Look at desired parameters.

QS200 Meter	Numerical Value (values must be greater than zero - check parameters entered if values are < or = to 0)	Units
Min Theoretical average Power Consumption - 0 HZ	0.00624	Watts
Max Theoretical average Power Consumption - 111 HZ	0.060535432	Watts
Pulse Power (Instant Maximum)	0.108590864	Watts
Max GPM	82	GPM
Max Frequency GPM (HZ)	103.456977	HZ
Min GPM	0.55	GPM
Min Frequency GPM (HZ)	0.693918748	HZ
Customer desired GPM (between Max and Min GPM)	20	GPM
Custermer disired GPM Frequency (HZ)	25.23340903	HZ
Pipe Size in INCHES (Choose 1, 1.5, 2, 3, or 4)	1.5	INCHES
K-Factor	0.7926	

		Units
Maximum or Peak Current (Amps)	0.003680476	AMPS
Minimum Average Power Consumption in Watts (@ Min GPM value)	0.006579429	Watts
Maximum Average Power Consumption in Watts (@ Max GPM Value)	0.056845777	Watts
Customer desired GPM (between Max and Min GPM) Average Power Consumption in Watts	0.018582873	Watts

Desired Parameters

Customer Parameters (Enter Values in blank Cells right of this spreadsheet)	Enter Values Below	Units
Pipe Size in INCHES (Choose 1, 1.5, 2, 3, or 4)	1.5	INCHES
Vsupply (Volts) - Must Be between 7.5 - 36 V (DC)	31.2	Volts (DC)
Pull-up resistance (R_p) Ohms	8914.29	Ohms
Customer desired flow rate GPM (Must be between min and max flow rate as specified in data sheet)	20	GPM
Tee K-Factor (Select Tee You Are Using) ◉ FLOMEC Tee K-Factor (Freq) ○ NON-FLOMEC Tee K-Factor (Freq)		
Note: Minimum Current = Quiescent Current = .0002 A = .2 mA		
		Units
Pull-up Resistance Calculator	8914.285714	Ohms
Open Circuit Voltage (With an ohmmeter - measure open circuit voltage on the controller's flow meter input)	31.2	Volts
Short Circuit Current (With an ammeter – measure the short circuit current on controller's flow meter input - connecting ammeter across the flow meter input)	0.0035	Amps

Choose K-Factor type here

Figure 7