Assume a 10k pull up from host and external 2k pull up

Vcc=3.3V

Minimum SCL low time (t_{low}) = 1.3uS @ 400kHz

Minimum SCL high time (t_{high}) = 0.6uS @ 400kHz

We will assume rise and fall times are negilable to simplify
(otherwise I believe we would need to use a convolution)

IoL will be estimated using I=V/R without a drop across the open drain driver

IoL=3.3V/(10k//2.2k)

IoL=3.3V/(1.8k)

IoL=1.83mA

Assuming linearity of 0.4V @ 3mA (fair assumption since NFETs will operate in linear region of operation here)

1.83mA/3mA= 0.61

0.61x0.4V= 0.244V

P=VxI

So during SCL low time: power across NFET = 1.83mA x 0.244V

SCL low time: power across NFET = 446.5uW

So during SCL low time: power across pull ups = 1.83mA x (3.3V-0.244V)

SCL low time: power across pull ups = 5.59mW

Total power across FET and pullup during low= 6.037mW

% time low for SCL = t_{low}/ (t_{high}+t_{low})

% time low for SCL = 1.3uS/ (0.6uS+1.3uS)

% time low for SCL = 68.4%

Average power from SCL during communication = (% low of SCL) x (total power across FET and pull up during low)

Average power from SCL during communication = (0.684) x (6.037mW)

Average power from SCL during communication = 4.13mW

I ***think*** you can also say this would be the total power in terms of mWHr if
you assumed this occurred throughout an entire hour. (4.13mWHr)

If you only communicate 8% on the I2C bus for that hour then your SCL
usage would be = 4.13mWHr x .08 → 0.3304mWHr

SDA can vary too much to give any sort of good estimate, worst case
occurs when SDA is low for all data sent.

Going through the exercise though, the total power when the SDA is low is the same as
when SCL is low across the FET and pullup. For worst case, would say SDA is low 100% of
the time so we don't need to calculate the % low time.

If you only communicate 8% on the I2C bus for that hour then your SDA
usage would be = 6.037mWHr x .08 → 0.483mWHr

Total worst case = 0.483mWHr + 0.3304mWHr

Total worst case = 0.8134mWHr

Assume a 10k pull up from host and 10k internal pull up from TCA9416

V_{cc}=3.3V

Minimum SCL low time (t_{low}) = 1.3uS @ 400kHz

Minimum SCL high time (t_{high}) = 0.6uS @ 400kHz

We will assume rise and fall times are negilable to simplify
(otherwise I believe we would need to use a convolution)

IoL will be estimated using I=V/R without a drop across the open drain driver

IoL=3.3V/(10k//10k)

IoL=3.3V/(5k)

IoL=0.66mA

Calculating this a second time, I realized we can just do Vcc x IoL instead of
the more tedious way I'm used to

P=VxI

P = 3.3V x 0.66mA

Total power across FET and pullup during low= 2.178mW

% time low for SCL = t_{low}/ (t_{high}+t_{low})

% time low for SCL = 1.3uS/ (0.6uS+1.3uS)

% time low for SCL = 68.4%

Average power from SCL in system = (% low of SCL) x (total power across FET and pull up during low)

Average power from SCL in system = (0.684) x (2.178mW)

Average power from SCL in system = 1.49mW

Power from supply of TCA9416 when idle = Vcc x (IccA+IccB)

Power from supply of TCA9416 when idle = 3.3V x 23uA

Power from supply of TCA9416 when idle = 76uW

This seems quite neglectable when compared to mW so I will omit this from further calculations

SDA can vary too much to give any sort of good estimate, worst case
occurs when SDA is low for all data sent.

Going through the exercise though, the total power when the SDA is low is the same as
when SCL is low across the FET and pullup. For worst case, would say SDA is low 100% of
the time so we don't need to calculate the % low time.

I ***think*** you can also say this would be the total power in terms of mWHr if
you assumed this occurred throughout an entire hour. (1.49mWHr)

If you only communicate 8% on the I2C bus for that hour then your SCL
usage would be = 1.49mWHr x .08 → 0.1192mWHr

If you only communicate 8% on the I2C bus for that hour then your SDA
usage would be = 2.178mWHr x .08 → 0.1742mWHr

Total worst case = 0.1192mWHr + 0.1742mWHr

Total worst case = 0.2934mWHr

Comparing the external 2.2k to the TCA9416: 0.8134mWHr vs. 0.2934mWHr

This appears to give a 64% reduction of power → 0.64 =({0.8134-0.2934}/0.8134)