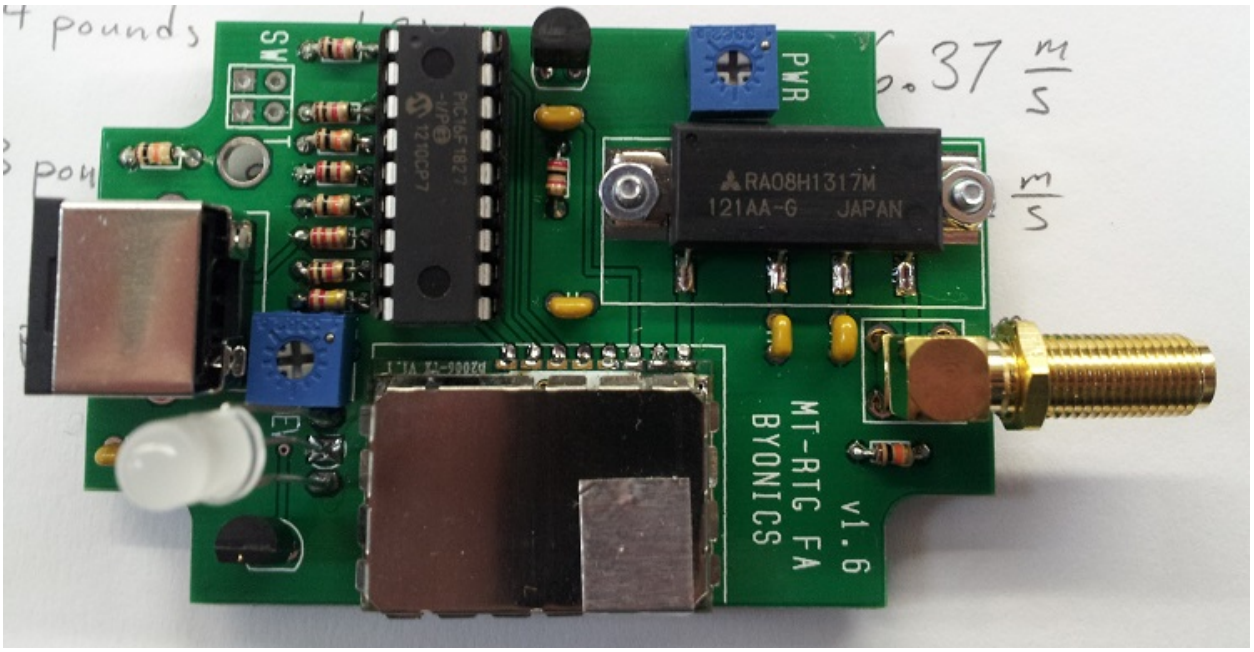


HABEX – Radio Alpha – Micro Trak RTG FA – Circuit Analysis

Circuit Analyst: Ara Kourchians

Abstract:

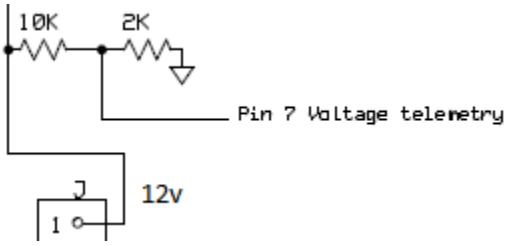
The goal of this analysis is to determine nominal, minimum, and maximum operating conditions. The required parameters are:

- **Operating Input Voltage Range:** $8v \leq V_{in} \leq 15.0v$
- **Expected Output Voltage Range:** $4.8v \leq V_{5v} \leq 5.2v$
- **Operating Temperature Range:** **-30C to +80C**
- **RF Power Range:** **1.75W - 2.25W**

Operating Input Voltage Range

In this analysis $V_{in} = V_{12v}$ which is ideally 12v. From this analysis we can determine how much variation would allow the device to function within margin.

V-Telemetry Circuit



Operating Voltage: $0v \leq V_{in} \leq (Maximum\ Input\ Voltage\ of\ Pin\ 7)$

Based on the PIC16F1826 datasheet: Maximum Input Voltage of Pin 7 – 5.5v

$$5.5v = \left(\frac{2k\Omega}{2k\Omega + 10k\Omega}\right) * V_{in\ max}$$

The maximum voltage for the V-Telemetry circuit is:

$$V_{in\ max} = 33v$$

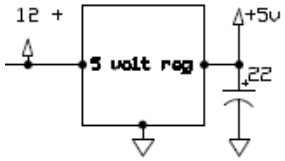
Thus, the operating voltage for the V-Telemetry circuit is:

$$0v \leq V_{in} \leq 33v$$

Based on the resistor datasheet: Operating Temperature:

-40C to +125C

5v Regulator Circuit



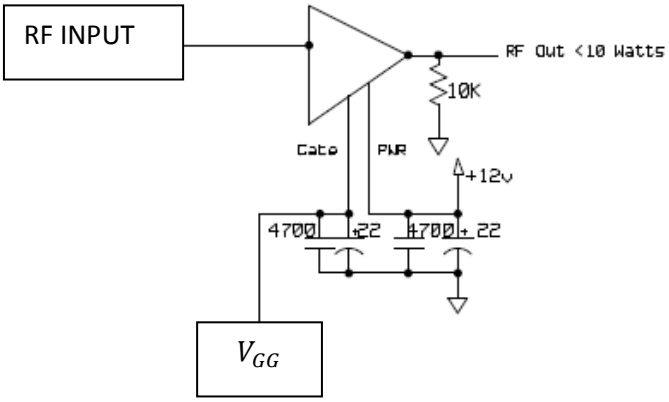
Based on the GJ7805 datasheet: Operating Input Voltage Range:

$$7.5v \leq V_{in} \leq 20v$$

Based on the GJ7805 datasheet: Operating Temperature:

-40C to +125C

RF Power Amplifier Circuit



Based on the RA08H1317M datasheet: Operating Input Voltage Range:

$$4v \leq V_{in} \leq 15.0v$$

Based on the RA08H1317M datasheet: Operating Temperature Range:

-30C to +125C

Circuit	Operating Input Voltage Range	Operating Temperature Range
V-Telemetry Circuit	$0v \leq V_{in} \leq 33v$	-40C to +125C
5v Regulator Circuit	$7.5v \leq V_{in} \leq 20v$	-40C to +125C
RF Power Amplifier Circuit	$4v \leq V_{in} \leq 15.0v$	-30C to +125C
Final Parameters:	$\mathbf{7.5v \leq V_{in} \leq 15.0v}$	-30C to +125C

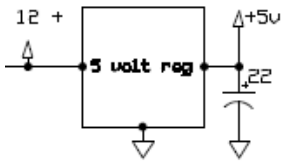
Operating Input Voltage Range: $\mathbf{7.5v \leq V_{in} \leq 15.0v}$

BATTERY VOLTAGE MUST WITHIN THE OPERATING INPUT VOLTAGE

Operating Logic Voltage Range

In this analysis $V_{in} = V_{5v}$ which is ideally 5v. We compare the 5v Regulators output (with error) to the logic voltage range. From this analysis we can determine how much variation would allow the device to function within margin.

5v Regulator Output Circuit



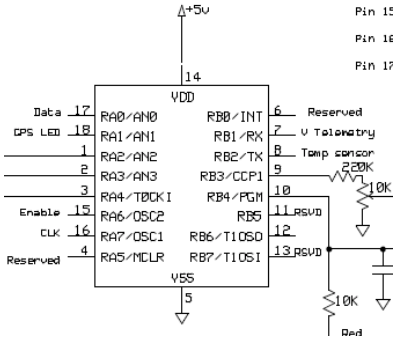
Using the GJ7805 datasheet:

Output Voltage Range: $4.8v \leq V_{5v} \leq 5.2v$ typically 5v

Based on the GJ7805 datasheet: Operating Temperature:

-40C to +125C

PIC16F1826 Circuit



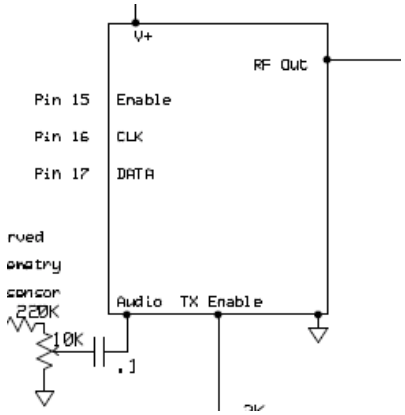
Based on the PIC16F1826 datasheet: Operating Input Voltage Range:

$$1.8v \leq V_{5v} \leq 5.5v$$

Based on the PIC16F1826 datasheet: Operating Temperature Range:

-40C to +125C

MCD2006G Circuit



Based on the MCD2006G datasheet: Operating Input Voltage Range:

$$2.5v \leq V+ \leq 4.5v$$

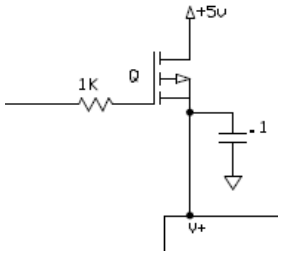
Since the MCD2006G uses a LDO to drop the voltage from 5v to 3.3v, the logic voltage variations affect the LDO, which directly affects the MCD2006G:

$$4.5v \leq V_{5v} \leq 12v$$

Based on the MCD2006G datasheet: Operating Temperature Range:

-40C to +85C

BJT Circuit



Based on the 2N3906 datasheet: Operating Input Voltage Range:

$$0v \leq V_{5v} \leq 40v$$

Based on the 2N3906 datasheet: Operating Temperature Range:

-55C to +150C

Circuit	Operating Output Voltage Range	Operating Temperature Range
5v Regulator Output Circuit	$4.8v \leq V_{5v} \leq 5.2v$	-40C to +125C
PIC16F1826 Circuit	$1.8v \leq V_{5v} \leq 5.5v$	-40C to +80C
MCD2006G Circuit	$4.5v \leq V_{5v} \leq 12v$	-30C to +125C
BJT Circuit	$0v \leq V_{5v} \leq 40v$	-55C to +150C
Final Parameters:	$\mathbf{4.5v \leq V_{5v} \leq 5.5v}$	-30C to +80C

Operating Output Voltage Range: $\mathbf{4.5v \leq V_{5v} \leq 5.5v}$

Expected Output Voltage Range: $\mathbf{4.8v \leq V_{5v} \leq 5.2v}$

OPERATING VOLTAGE IS WITHIN THE EXPECTED OUTPUT VOLTAGE

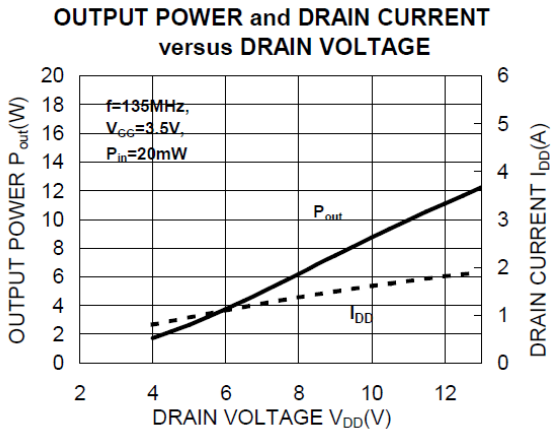
Operating Temperature Range

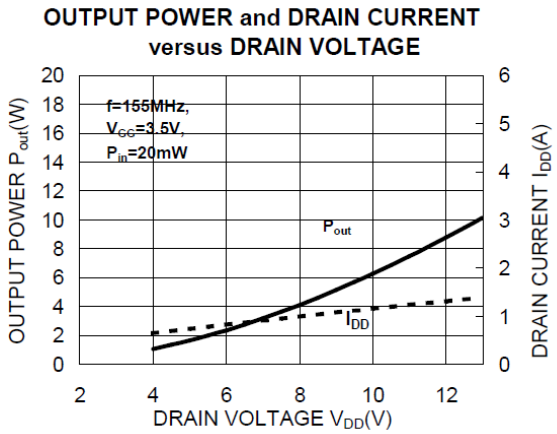
In this analysis we determine the safe operating temperature of the device as a whole. Using the Temperature ranges from the data above we can conclude the following:

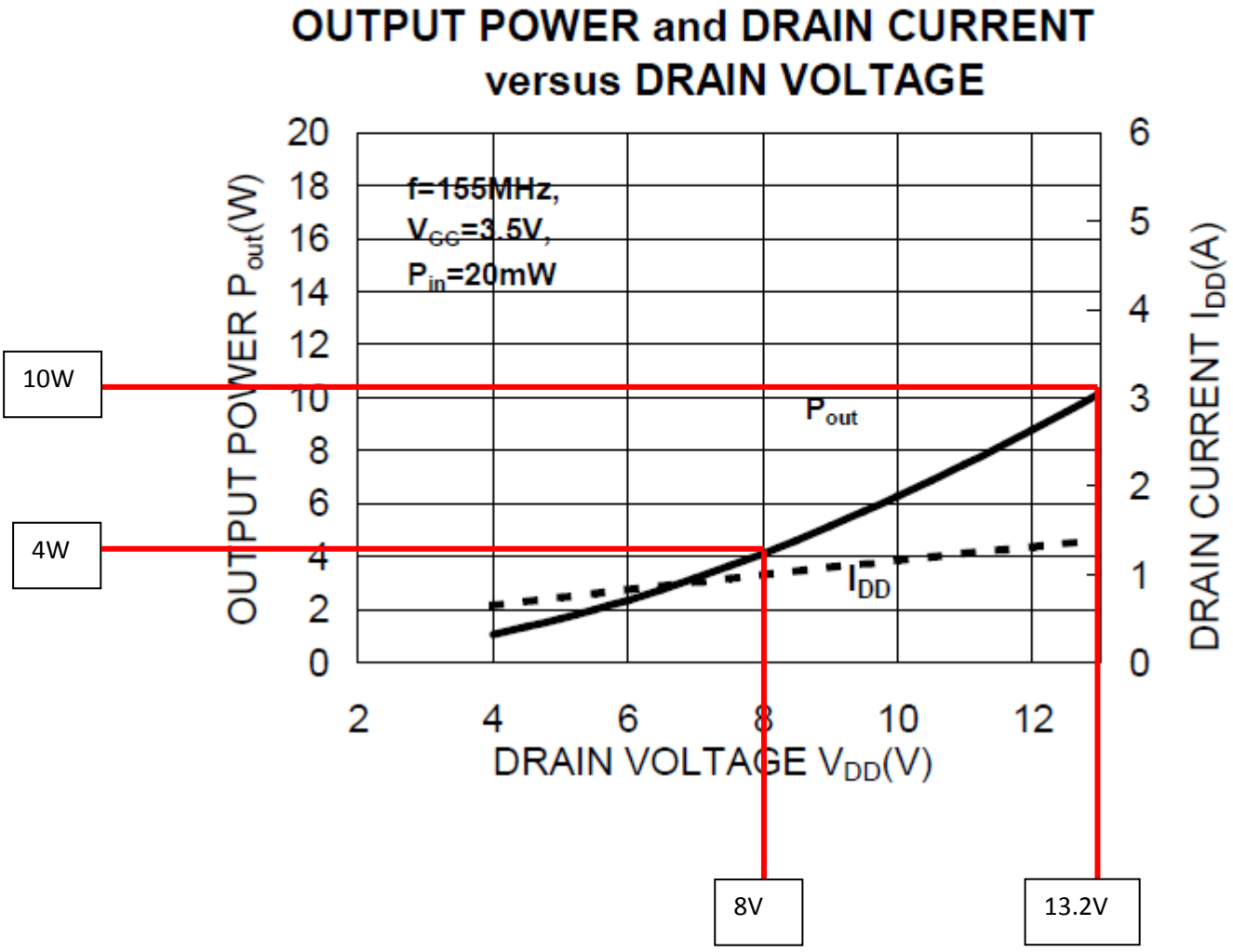
Operating Temperature Range: **-30C to +80C**

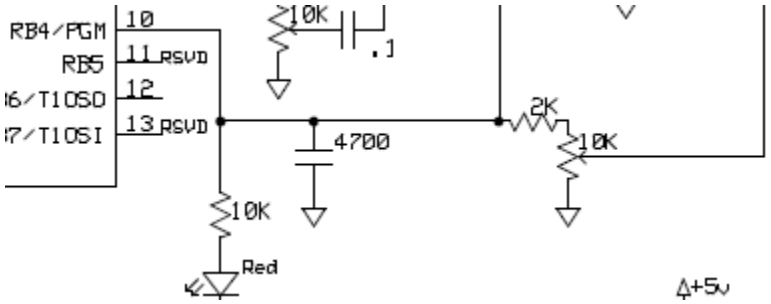
RF Power Range

Using the RA08H1317M datasheet:



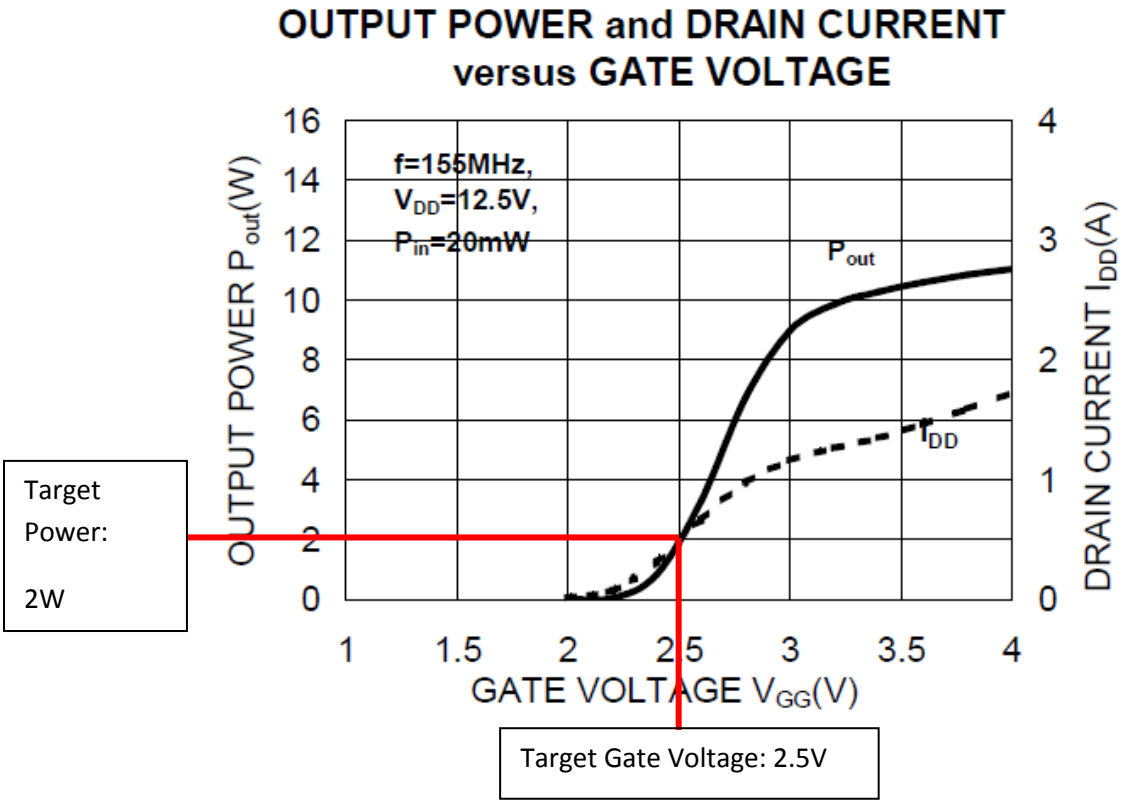






From this circuit we can see the gate is controlled by a voltage divider of the logic voltage (V_{5v})

Our target power is 2W:



$$2.5v = V_{5v}\left(\frac{R}{2k\Omega + R}\right)$$

Ideal/nominal case:

$$2.5v = 5v\left(\frac{R}{2k\Omega + R}\right)$$

$$\boldsymbol{R = 2.0k\Omega}$$

From here, we fix R since we cannot change that during flight. We then apply the maximum and minimum logic voltage to determine how much of a power variation to expect.

Max logic voltage case:

$$V_{gg\ max} = 5.2v\left(\frac{2k\Omega}{2k\Omega + 2k\Omega}\right)$$

$V_{gg\ max} = 2.60v$ $\quad$ $P_{RF\ OUT\ MAX} = 2.25W$

Min logic voltage case:

$$V_{gg\ min} = 4.8v\left(\frac{2k\Omega}{2k\Omega + 2k\Omega}\right)$$

$V_{gg\ min} = 2.40v$ $\quad$ $P_{RF\ OUT\ MIN} = 1.75W$

Expected RF Power: **2 Watt**

RF Power Variation Range: **1.75W - 2.25W**