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Teensy 4.x / IMXRT1062 - max output current

Asked 3 years, 3 months ago Modified 3 years, 3 months ago Viewed 2k times



3



For my projects next revision, I'd like to drop the ULN2803A transistor array I currently use to drive eight optocouplers. Using optocouplers with a lower current requirement means that I'd only need to sink / source 5 mA of current for each of the eight pins.

Unfortunately, neither the [datasheet for the MCU](#) nor the [specs of the development board](#) include a rating I'm used to - like the 40 mA per I/O pin limit on the [ATmega328P](#).



Table 12 of the datasheet ([1](#)) contains a formula for some I_{max} ;

$$I_{max} = N \times C \times V \times (0.5 \times F)$$

where F is the "Data change rate" in Hz - but I believe that would imply I couldn't supply *any* current if the outputs were static, which is probably not the case.

What currents can this MCU sink / source? How do I calculate that? Can I (safely) drive eight 5 mA optocouplers directly via the MCU?

microcontroller

current

teensy

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asked Jun 19, 2020 at 6:28



towe

168 11

2 Answers

Sorted by: Highest score (default)



1

I think you are misinterpreting the datasheet. That I_{max} is how much current the GPIO is consuming. Because it's CMOS based DC current is negligible. Higher data rates increase current consumption.



I looked through the datasheet and did not find an absolute max GPIO output current. For what it's worth tables 26/27 mentions GPIO output impedance.



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answered Jun 19, 2020 at 6:44



Yet Another Michael

2,062 1 10 18

That sounds a lot more reasonable. I suppose I'd want to set the drive strength to its maximum for the optocoupler pins and then use a current limiting resistors as $R_{led} = ((3.3V - V_f) / I_f) - R_{drv}$? – towe Jun 19, 2020 at 6:51

That seems like a sound idea. For 5mA the ~23Ω of output resistance shouldn't muck with the resistor sizing too much (would give 4.8mA instead of 5mA assuming 1.15V forward voltage drop, 3.3V GPIO output, and 23Ω output impedance). Taking into account the output resistance results in closer actual output to the target 5mA. – Yet Another Michael Jun 19, 2020 at 7:35



1

There's no single answer to this. That's why NXP doesn't state it explicitly in the datasheet.

Maximum output current depends on several factors:



1. IO drive strength (DSE) with value range: 001,010,011,100,101,110,111
2. Operating voltage
3. Slew rate, fast or slow



The easiest way is to use GPIO output buffer avg impedance from the datasheet to calculate *maximum possible* current the pin could drive (See Warning below).

See the table below, let's assume you're working on 3.3v with max drive strength (111). So

you have maximum current = $3.3\text{V}/23\ \Omega = 143.5\text{mA}$. But this is just a coarse value.

4.3.3.1 Single voltage GPIO output buffer impedance

Table 26 shows the GPIO output buffer impedance (NVCC_XXXX 1.8 V).

Table 26. GPIO output buffer average impedance (NVCC_XXXX 1.8 V)

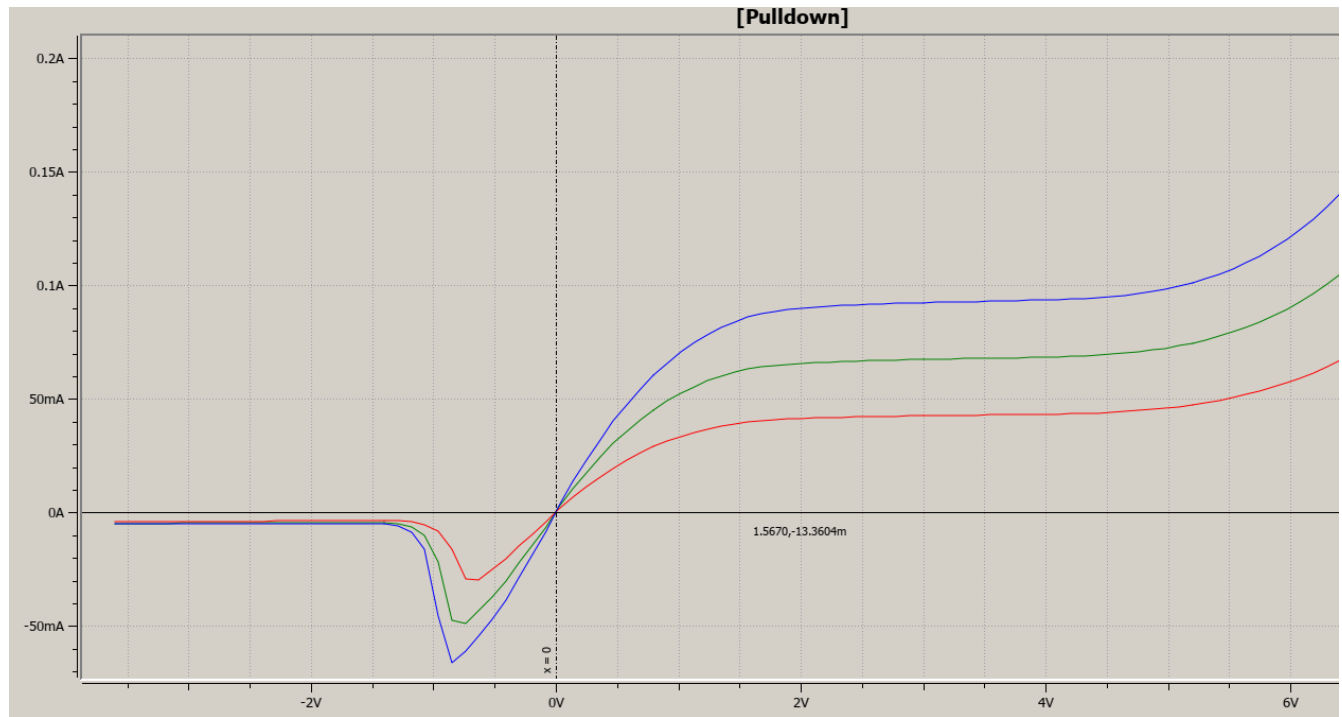
Parameter	Symbol	Drive Strength (DSE)	Typ Value	Unit
Output Driver Impedance	Rdrv	001	260	Ω
		010	130	
		011	88	
		100	65	
		101	52	
		110	43	
		111	37	

Table 27 shows the GPIO output buffer impedance (NVCC_XXXX 3.3 V).

Table 27. GPIO output buffer average impedance (NVCC_XXXX 3.3 V)

Parameter	Symbol	Drive Strength (DSE)	Typ Value	Unit
Output Driver Impedance	Rdrv	001	157	Ω
		010	78	
		011	53	
		100	39	
		101	32	
		110	26	
		111	23	

The better way to know it is to read the I-V Curve from their IBIS Model. The curve below is taken from the RT1060 series IBIS Model. ~92mA max current @ 3.3v.



Warning

just because you can doesn't mean you should. Now, although you can drive 90mA, the real question is for how long? some IBIS Model includes data outside its absolute rating. So, maybe you could drive 90mA, but only, for example, 30 nanoseconds.

Also, you may drive 90mA longer, but you need to keep the chip cool enough so it won't fry itself. In this case, max current is correlated with your ability to keep the Junction Temperature low.

Finally, the general recommendation from NXP is this: use buffer (transistor, etc) to drive your load. Don't drive high power load with GPIO pins.

i.MX RT1062 is a Crossover Processor from NXP, meaning that this is actually a microprocessor equipped with peripherals, not an MCU with super-high performance. Being a microprocessor, the Crossover processor doesn't have the strength like MCUs have.

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answered Jun 19, 2020 at 11:16



rosmianto

178 9

Very nice, thank you! I believe that I-V curve is what I was missing. Judging from it, I suppose 5 mA for a maximum of 25 us, 50% duty cycle should be fine - I'll see when I try it out. – [towe](#) Jun

19, 2020 at 12:51
