Introduction

The superior gas sensing capability of IDT's SGAS line of solid-state gas sensors is best realized though a precision analog front-end circuit design that incorporates low-noise, high-accuracy heater control and resistance measurement. The reference design shown in this application note corresponds to circuitry used in the electronic module included as part of the SMOD7xx Evaluation Kit, which can be used to evaluate IDT's SGAS701, SGAS707, and SGAS711 sensors. See Figure 1 for the reference design circuit and the locations of the components and signals discussed in the following sections.

Circuit Description

Two voltage-controlled constant-current drivers separately drive the heater and sensor current. U1 and Q1-A force a voltage drop across R1 equal to V_{input}. The current i_{R1} through the R1-Q1A-R2 network is consequently fixed at a value proportional to V_{input} as calculated with Equation 1.

$$i_{R1} = i_{Q1\text{-}A} = i_{R2} = \frac{V_{input}}{R1} \qquad \textbf{Equation 1}$$

The voltage drop across R2 is determined via Equation 2:

$$V_{R2} = i_{Q1\text{-}A} * R2 = \frac{V_{input}}{R1} * R2 \qquad \textbf{Equation 2}$$

The voltage drop across R3, which is controlled by U2 and Q1-B, is the same as the drop across R2 as shown in Equation 3:

$$V_{R3} = \frac{V_{input}}{R1} * R2 = i_{R3} * R3 \qquad \textbf{Equation 3}$$

Solving the right-side of the equality in Equation 3 for i_{R3} gives Equation 4:

$$i_{R3} = V_{input} * \frac{R2}{R1 * R3} \qquad \textbf{Equation 4}$$

The R1 through R3 resistor values given in the reference design circuit bill-of-materials (BOM) listed in Table 1 produce the voltage-to-current relationship shown in Equation 5:

$$i_{R3} = V_{input} * 0.06032 \qquad \textbf{Equation 5}$$

At V_{input} = 2.5V, the heater current is equal to approximately 151mA, which is enough to operate all SGAS7xx sensor types. Tests of the above circuit have shown current-drive accuracy of better than 1% for currents across a range of 5mA to 150mA.

The sensor current drive circuit shown in the top half of Figure 1 operates the same as the heater drive circuit, but within a much smaller current range set by R4 through R6. At V_{input} = 2.5V, the heater current is equal to approximately 41.5µA. Applying this current to a gas sensor having a resistance of 50kΩ would result in a voltage of approximately 2.07V.

Designers using this reference design as the basis for modified circuits should keep the following in mind:

- Amplifiers operate at or near the supply rails in most cases, requiring use of rail-to-rail type amplifiers.
- Heater amplifiers must be voltage compliant with the heater-drive voltage, which can go as high as 7V.
- Currents (particularly in the sensor driver) are very small. Ensure that the input bias current is small enough that it does not significantly subtract from the targeted drive current

This reference design takes into consideration requirements for compatibility with MCU applications. Additional circuit elements (such signal filtering and attenuation) are purposely not included in Figure 1 since design of these elements is specific to the MCU selection and other application driven requirements.

Figure 1. SMOD Analog Front End Reference Design

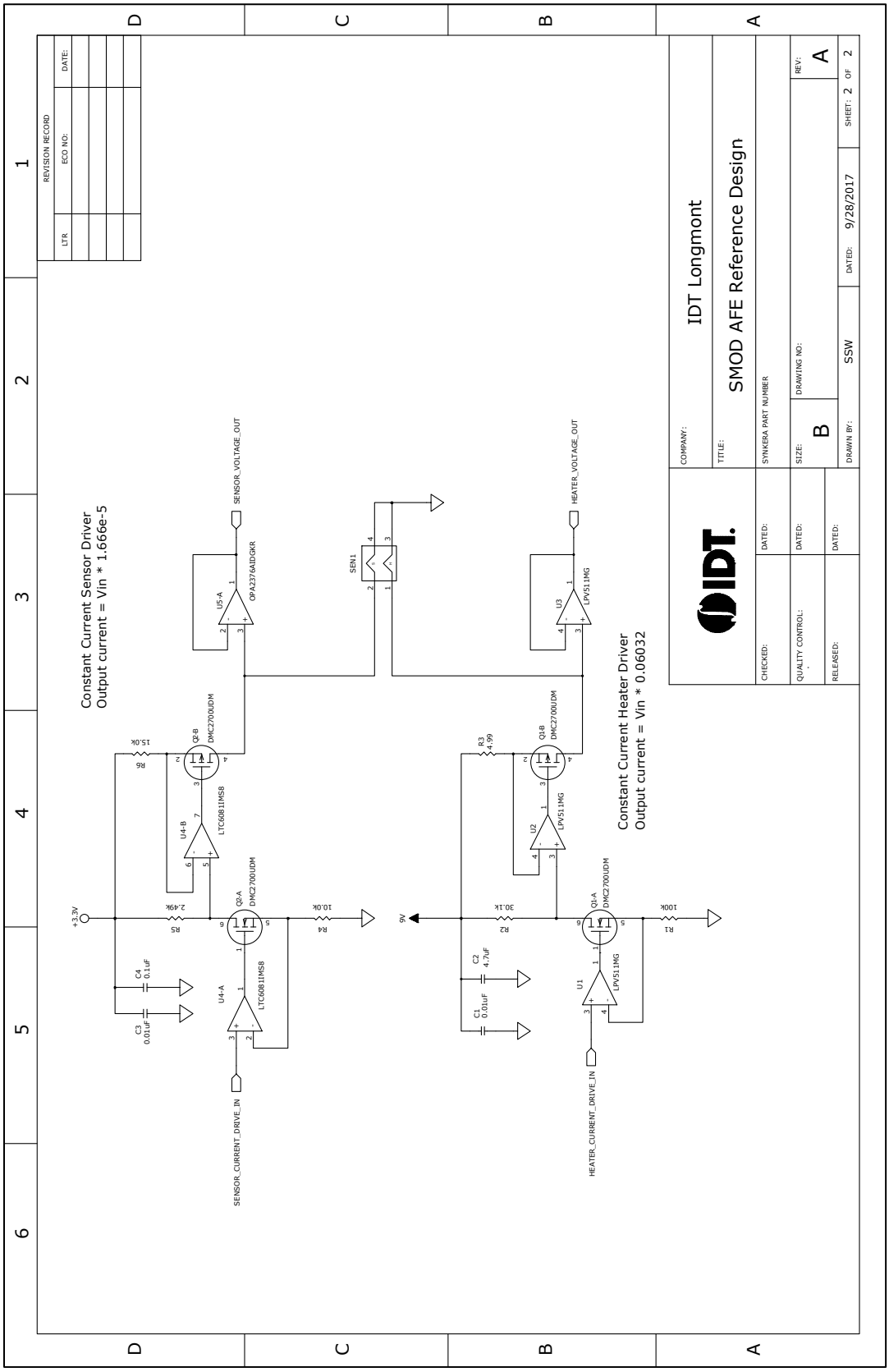

Figure 2. Table 1. Bill of Materials

Qty	Reference	Description	Manufacturer	Manufacturer P/N
2	C1, C3	Capacitor ceramic 0.01µF X7R 10V 0402 10%	Samsung	CL05B103KP5NNNC
1	C2	Capacitor ceramic 4.7µF X5R 10V 0805 10%	Samsung	CL21A475KPFNNNE
1	C4	Capacitor ceramic 0.1uF X5R 10V 0402 10%	Samsung	CL05A104KP5NNNC
2	Q1, Q2	MOSFET N/P-CH 20V SOT26	Diodes Inc.	DMC2700UDM-7
1	R1	Resistor 100k SMT 0402 1% 1/16W	Stackpole	RMCF0402FT100K
1	R2	Resistor 30.1k SMT 0402 1% 1/16W	Stackpole	RMCF0402FT30K1
1	R3	Resistor 4.99 SMT 0603 1% 1/10W	Stackpole	RMCF0603FT4R99
1	R4	Resistor 10.0k SMT 0402 1% 1/10W	Stackpole	RMCF0402FT10K0
1	R5	Resistor 2.49k SMT 0402 1% 1/10W	Stackpole	RMCF0402FT2K49
1	R6	Resistor 15.0k SMT 0402 1% 1/10W	Stackpole	RMCF0402FT15K0
1	SEN1	TO-39 pin sockets (4)	Mill-Max	917-93-104-41-005000
3	U1, U2, U3	IC OPAMP GP 25KHZ RRO SC70-5	TI	LPV511MG/NOPB
1	U4	IC OPAMP GP 3.5MHZ RRO 8MSOP	Linear Technology	LTC6081IMS8#PBF
1	U5	IC OPAMP GP 5.5MHZ RRO 8VSSOP	TI	OPA2376AIDGKR

Revision History

Revision Date	Description of Change
October 19, 2017	Initial release

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