

# GTM CORPORATION

ISSUED DATE :2006/03/07  
REVISED DATE :

## GSC2176

### 600mA CMOS Positive Voltage Regulator

#### Description

The GSC2176 of positive, linear regulators feature low ground current (30µA typ.) with low dropout voltage, making them ideal for battery applications. The space-saving SOP-8 package is attractive for "Pocket" and "Hand Held" applications.

These rugged devices have both Thermal Shutdown, and Current Fold-back to prevent device failure under the "Worst" of operating conditions.

The GSC2176 is stable with an output capacitance of 2.2µF or greater.

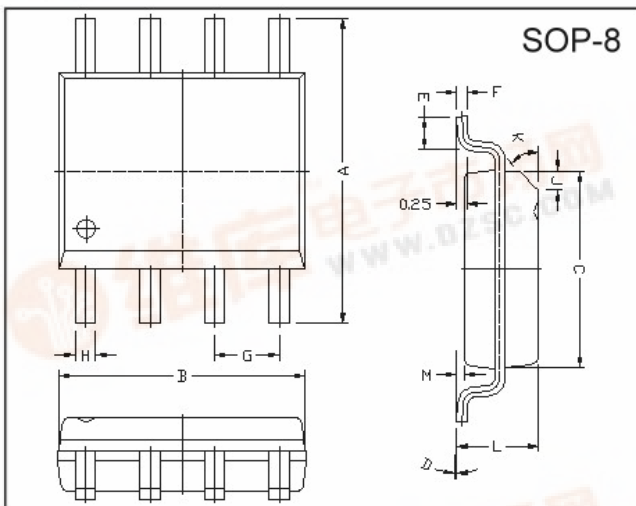
#### Features

- Very Low Dropout Voltage
- Guaranteed 600mA output
- Accurate to within 1.5%
- Over-Temperature Shutdown
- Current Limiting
- Short Circuit Current Fold-back
- Low Temperature Coefficient
- Power-saving Shutdown Mode
- User Adjustable Output Voltages

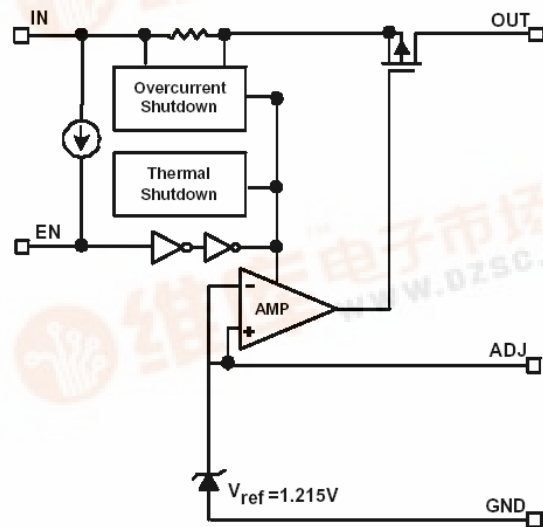
#### Applications

- Battery Powered Widgets
- Instrumentation
- Wireless Devices
- Cordless Phones
- PC Peripherals
- Portable Electronics

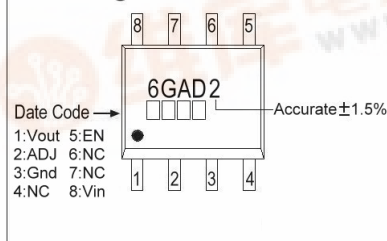
#### Package Dimensions



#### Functional Block Diagram

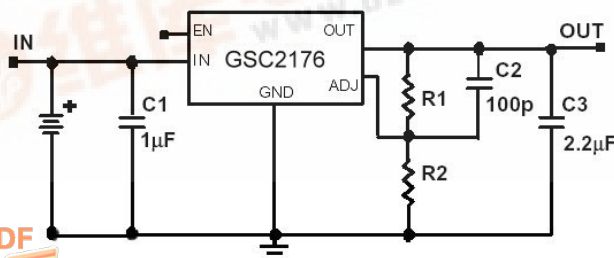


#### Marking :



| REF. | Millimeter |      | REF. | Millimeter |      |
|------|------------|------|------|------------|------|
|      | Min.       | Max. |      | Min.       | Max. |
| A    | 5.80       | 6.20 | M    | 0.10       | 0.25 |
| B    | 4.80       | 5.00 | H    | 0.35       | 0.49 |
| C    | 3.80       | 4.00 | L    | 1.35       | 1.75 |
| D    | 0°         | 8°   | J    | 0.375 REF. |      |
| E    | 0.40       | 0.90 | K    | 45°        |      |
| F    | 0.19       | 0.25 | G    | 1.27 TYP.  |      |

#### Typical Application Circuit



$$V_{OUT} = 1.215 * (1 + R1/R2)$$

C2 is unnecessary if R1 or R2 < 20KΩ

R1 and R2 use resistance value within 1% accuracy for correct Vout

**Absolute Maximum Ratings**

| Parameter                     | Symbol             | Ratings  | Unit |
|-------------------------------|--------------------|--|------|
| Input Max Voltage             | V <sub>IN</sub>    | 8  | V    |
| Output Current                | I <sub>OUT</sub>   | P <sub>D</sub> /( V <sub>IN</sub> - V <sub>O</sub> ) | mA   |
| Output Voltage                | V <sub>OUT</sub>   | Gnd-0.3 to V <sub>IN</sub> +0.3                      | V    |
| Operating Ambient Temperature | T <sub>opr</sub>   | -40 ~ +85  | °C   |
| Junction Temperature          | T <sub>j</sub>     | -40 ~ +125   | °C   |
| Maximum Junction Temperature  | T <sub>j Max</sub> | 150  | °C   |
| Internal Power Dissipation    | P <sub>D</sub>     | 810  | mW   |
| EDS Classification            |                    | B  |      |

**Electrical Characteristics T<sub>A</sub>=25°C unless otherwise noted**

| Parameter                              | Symbol                         | Condition   | Min                            | TYP                            | Max             | Unit   |    |
|--|--------------------------------|---|--------------------------------|--------------------------------|-----------------|--------|----|
| Output Voltage                         | V <sub>OUT(E)</sub><br>(Note1) | I <sub>O</sub> =1mA, V <sub>IN</sub> =V <sub>OUT(T)</sub> +2V                               | -1.5                           | V <sub>OUT(T)</sub><br>(Note2) | 1.5             | %      |    |
| Output Current                         | I <sub>O</sub>                 | V <sub>O</sub> >1.2V  | 600                            | -                              | -               | mA     |    |
| Current Limit                          | I <sub>LIM</sub>               | V <sub>O</sub> >1.2V  | 600                            | 800                            | -               | mA     |    |
| Short Circuit Current                  | I <sub>SC</sub>                | V <sub>IN</sub> =V <sub>OUT(T)</sub> +1V, V <sub>O</sub> < 0.8V                             | -                              | 300                            | 600             | mA     |    |
| Load Regulation                        | REG <sub>LOAD</sub>            | V <sub>IN</sub> =V <sub>OUT(T)</sub> +2V, I <sub>O</sub> =1mA to 600mA                      | -                              | 0.2                            | 1               | %      |    |
| Dropout Voltage                        | V <sub>DROPOUT</sub>           | I <sub>O</sub> =600mA<br>V <sub>O</sub> =V <sub>OUT(E)</sub> -2%                            | 1.5V<V <sub>OUT(T)</sub> ≤2.0V | -                              | -               | 1400   | mV |
|  |                                |   | 2.0V<V <sub>OUT(T)</sub> ≤2.8V | -                              | -               | 800    |    |
|  |                                |   | 2.8V<V <sub>OUT(T)</sub>       | -                              | -               | 600    |    |
| Ground Pin Current                     | I <sub>GND</sub>               | V <sub>IN</sub> =V <sub>OUT(T)</sub> +2V, I <sub>O</sub> =1mA to 600mA                      | -                              | 30                             | -               | μA     |    |
| Line Regulation                        | REG <sub>LINE</sub>            | I <sub>O</sub> =1mA<br>V <sub>IN</sub> =V <sub>OUT(T)</sub> +1 to<br>V <sub>OUT(T)</sub> +2 | V <sub>OUT(T)</sub> <2.0V      | -                              | -               | 0.15   | %  |
|  |                                |   | V <sub>OUT(T)</sub> ≥2.0V      | -                              | 0.02            | 0.1    |    |
| Input Voltage                          | V <sub>IN</sub>                |   | Note3                          | -                              | 7               | V      |    |
| Over Temperature Shutdown              | OTS                            |   | -                              | 150                            | -               | °C     |    |
| Over Temperature Hysterisis            | OTH                            |   | -                              | 30                             | -               | °C     |    |
| Output Voltage Temperature Coefficient | TC                             |   | -                              | 30                             | -               | ppm/°C |    |
| Power Supply Rejection                 | PSRR                           | I <sub>O</sub> =100mA<br>C <sub>O</sub> =2.2μF  | f=1kHz                         | -                              | 50              | -      | dB |
|  |                                |   | f=10kHz                        | -                              | 20              | -      |    |
|  |                                |   | f=100kHz                       | -                              | 15              | -      |    |
| Output Voltage Noise                   | e <sub>N</sub>                 | f=10Hz~100kHz, I <sub>O</sub> =10mA, C <sub>O</sub> =2.2μF                                  | -                              | 30                             | -               | μVrms  |    |
| ADJ Reference Voltage                  | V <sub>REF</sub>               |   | 1.203                          | 1.215                          | 1.227           | V      |    |
| EN Input Threshold                     | V <sub>EH</sub>                | V <sub>IN</sub> =2.7V to 7V   | 2.0                            | -                              | V <sub>IN</sub> | V      |    |
|  | V <sub>EL</sub>                | V <sub>IN</sub> =2.7V to 7V   | 0                              | -                              | 0.4             | V      |    |
| EN Input Bias Current                  | I <sub>EH</sub>                | V <sub>EN</sub> =V <sub>IN</sub> , V <sub>IN</sub> =2.7V to 7V                              | -                              | -                              | 0.1             | μA     |    |
|  | I <sub>EL</sub>                | V <sub>EN</sub> = 0V, V <sub>IN</sub> =2.7V to 7V   | -                              | -                              | 0.5             | μA     |    |
| Shutdown Supply Current                | I <sub>SD</sub>                | V <sub>IN</sub> =5V, V <sub>O</sub> =0V, V <sub>EN</sub> <V <sub>EL</sub>                   | -                              | 0.5                            | 0.1             | μA     |    |

Note 1: V<sub>OUT(E)</sub> =Effective Output Voltage (i.e. the output voltage when "V<sub>OUT(T)</sub> + 2.0V" is provided at the V<sub>IN</sub> pin while maintaining a certain I<sub>OUT</sub> value).

2: V<sub>OUT(T)</sub> =Specified Output Voltage

3: V<sub>IN(MIN)</sub> =V<sub>OUT</sub>+V<sub>DROPOUT</sub>

## Ordering Information ( contd. )

| Part Number | Marking       | Output Voltage | Part Number | Marking | Output Voltage |
|-------------|---------------|----------------|-------------|---------|----------------|
| GSC2176-AD  | 6GAD2<br>XXXX | Adjustable     |             |         |                |

## Detailed Description

The GSC2176 of COMS regulator contain a PMOS pass transistor, voltage reference, error amplifier, over-current protection, and thermal shutdown.

The P-channel pass transistor receives data from the error amplifier, over-current shutdown, and thermal protection circuits. During normal operation, the error amplifier compares the output voltage to a precision reference. Over-current and Thermal shutdown circuits become active when the junction temperature exceeds 150°C, or the current exceeds 600mA. During thermal shutdown, the output voltage remains low. Normal operation is restored when the junction temperature drops below 120°C.

The GSC2176 switches from voltage mode to current mode when the load exceeds the rated output current. This prevents over-stress. The GSC2176 also incorporates current fold-back to reduce power dissipation when the output is short circuited. This feature becomes active when the output drops below 0.8 volts, and reduces the current flow by 65%. Full current is restored when the voltage exceeds 0.8 volts.

## External Capacitors

The GSC2176 is stable with an output capacitance to ground of 2.2μF or greater. Ceramic capacitors have the lowest ESR, and will offer the best AC performance. Conversely, Aluminum Electrolytic capacitors exhibit the highest ESR, resulting in the poorest AC response. Unfortunately, large value ceramic capacitors are comparatively expensive. One option is to parallel a 0.1uF ceramic capacitor with a 10uF Aluminum Electrolytic. The benefit is low ESR, high capacitance, and low overall cost.

A second capacitor is recommended between the input and ground to stabilize V<sub>IN</sub>. The input capacitor should be at least 0.1μF to have a beneficial effect.

All capacitors should be placed in close proximity to the pins. A "Quiet" ground termination is desirable. This can be achieved with a "Star" connection.

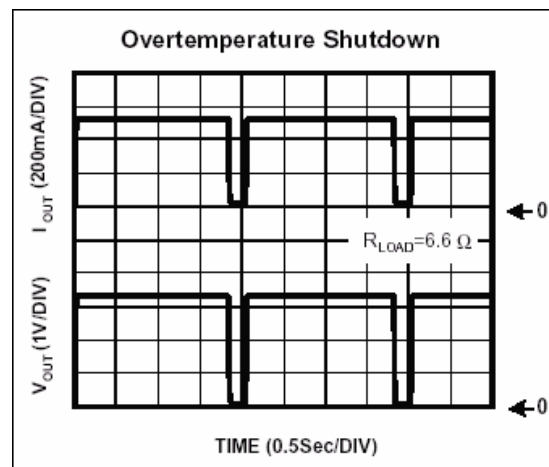
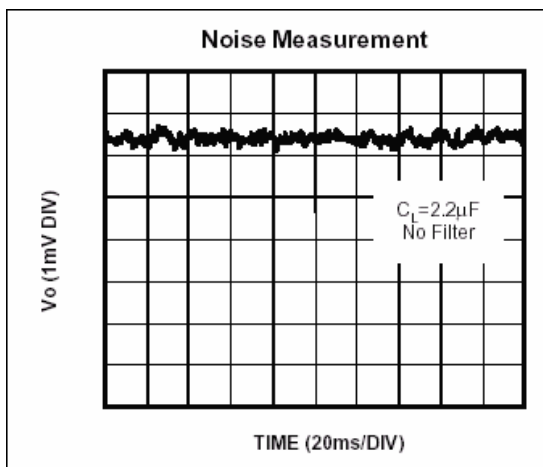
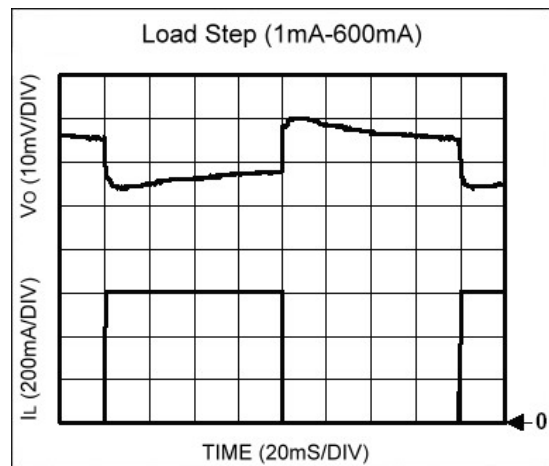
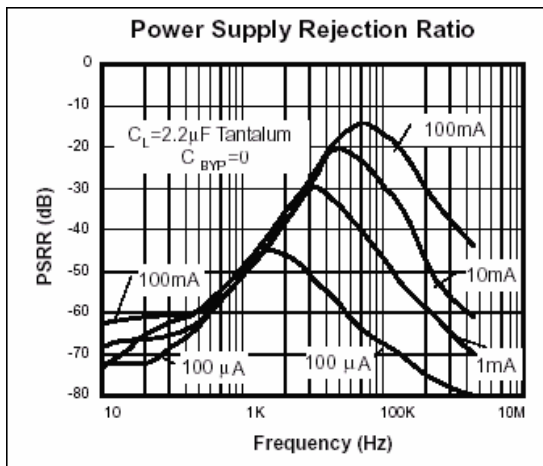
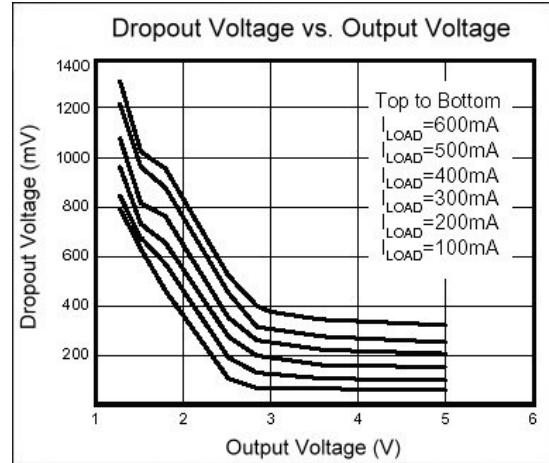
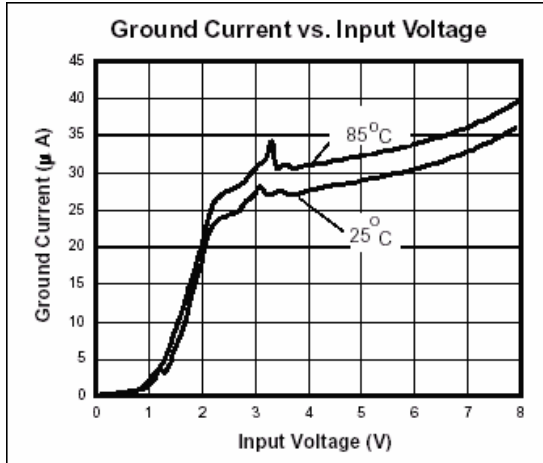
## Enable

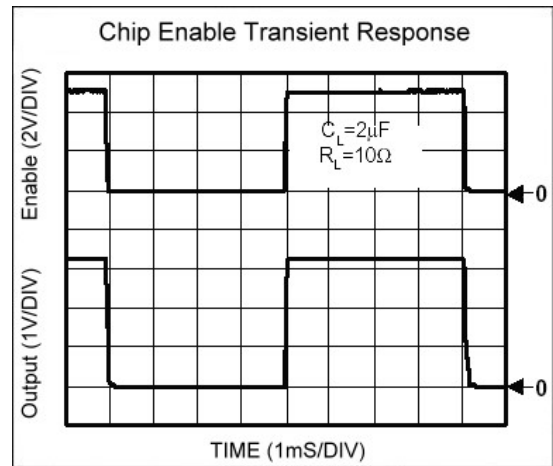
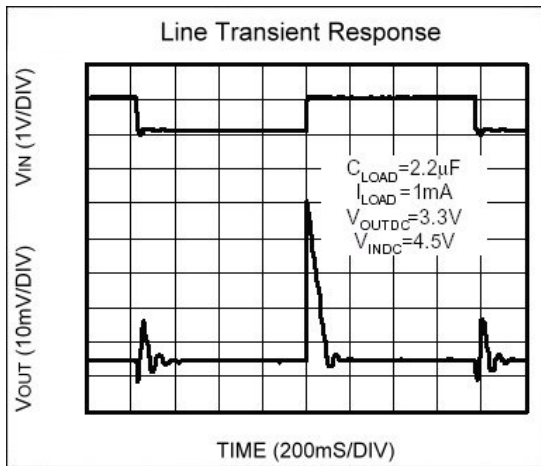
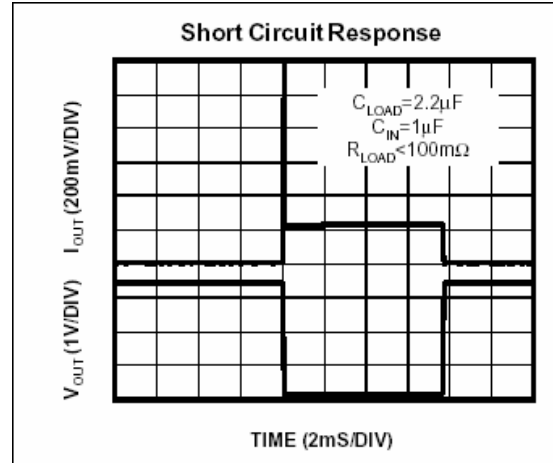
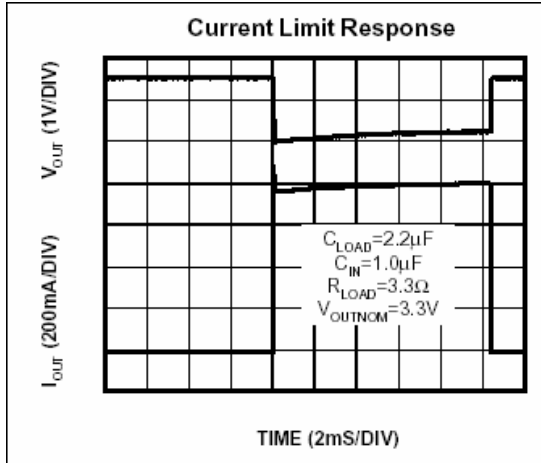
The Enable pin normally floats high. When actively, pulled low, the PMOS pass transistor shuts off, and all internal circuits are powered down. In this state, the quiescent current is less than 1μA. This pin behaves much like an electronic switch.

## ADJ

The ADJ pin is the positive input to the error amplifier which, due to the PMOS pass element inversion, means it is actually the negative input of the LDO feedback loop. The feedback works to keep the voltage at the ADJ pin 1.215V with respect to ground. Since the internal circuitry at the ADJ pin is essentially an ESD protected CMOS gate the input current at the ADJ pin is virtually zero.

## Characteristics Curve





External Resistor Divider Table

| R1(K Ohm) | 1  | 2     | 3     | 4     | 5     | 6     | 7      | 8      | 9      | 10     |
|-----------|--|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| VOUT      | $R2(K\text{ Ohm})=(1.215*R1(K\text{ Ohm}))/(VOUT-1.215)$ |       |       |       |       |       |        |        |        |        |
| 1.30      | 14.29  | 28.59 | 42.88 | 57.18 | 71.47 | 85.76 | 100.06 | 114.35 | 128.65 | 142.94 |
| 1.35      | 9.00   | 18.00 | 27.00 | 36.00 | 45.00 | 54.00 | 63.00  | 72.00  | 81.00  | 90.00  |
| 1.40      | 6.57   | 13.14 | 19.70 | 26.27 | 32.84 | 39.41 | 45.97  | 52.54  | 59.11  | 65.68  |
| 1.45      | 5.17   | 10.34 | 15.51 | 20.68 | 25.85 | 31.02 | 36.19  | 41.36  | 46.53  | 51.70  |
| 1.50      | 4.26   | 8.53  | 12.79 | 17.05 | 21.32 | 25.58 | 29.84  | 34.11  | 38.37  | 42.63  |
| 1.55      | 3.63   | 7.25  | 10.88 | 14.51 | 18.13 | 21.76 | 25.39  | 29.01  | 32.64  | 36.27  |
| 1.60      | 3.16   | 6.31  | 9.47  | 12.62 | 15.78 | 18.94 | 22.09  | 25.25  | 28.40  | 31.56  |
| 1.65      | 2.79   | 5.59  | 8.38  | 11.17 | 13.97 | 16.76 | 19.55  | 22.34  | 25.14  | 27.93  |
| 1.70      | 2.51   | 5.01  | 7.52  | 10.02 | 12.53 | 15.03 | 17.54  | 20.04  | 22.55  | 25.05  |
| 1.75      | 2.27   | 4.54  | 6.81  | 9.08  | 11.36 | 13.63 | 15.90  | 18.17  | 20.44  | 22.71  |
| 1.80      | 2.08   | 4.15  | 6.23  | 8.31  | 10.38 | 12.46 | 14.54  | 16.62  | 18.69  | 20.77  |
| 1.85      | 1.91   | 3.83  | 5.74  | 7.65  | 9.57  | 11.48 | 13.39  | 15.31  | 17.22  | 19.13  |
| 1.90      | 1.77   | 3.55  | 5.32  | 7.09  | 8.87  | 10.64 | 12.42  | 14.19  | 15.96  | 17.74  |
| 1.95      | 1.65   | 3.31  | 4.96  | 6.61  | 8.27  | 9.92  | 11.57  | 13.22  | 14.88  | 16.53  |
| 2.00      | 1.55   | 3.10  | 4.64  | 6.19  | 7.74  | 9.29  | 10.83  | 12.38  | 13.93  | 15.48  |
| 2.05      | 1.46   | 2.91  | 4.37  | 5.82  | 7.28  | 8.73  | 10.19  | 11.64  | 13.10  | 14.55  |
| 2.10      | 1.37   | 2.75  | 4.12  | 5.49  | 6.86  | 8.24  | 9.61   | 10.98  | 12.36  | 13.73  |
| 2.15      | 1.30   | 2.60  | 3.90  | 5.20  | 6.50  | 7.80  | 9.10   | 10.40  | 11.70  | 12.99  |
| 2.20      | 1.23   | 2.47  | 3.70  | 4.93  | 6.17  | 7.40  | 8.63   | 9.87   | 11.10  | 12.34  |
| 2.25      | 1.17   | 2.35  | 3.52  | 4.70  | 5.87  | 7.04  | 8.22   | 9.39   | 10.57  | 11.74  |
| 2.30      | 1.12   | 2.24  | 3.36  | 4.48  | 5.60  | 6.72  | 7.84   | 8.96   | 10.08  | 11.20  |
| 2.35      | 1.07   | 2.14  | 3.21  | 4.28  | 5.35  | 6.42  | 7.49   | 8.56   | 9.63   | 10.70  |
| 2.40      | 1.03   | 2.05  | 3.08  | 4.10  | 5.13  | 6.15  | 7.18   | 8.20   | 9.23   | 10.25  |
| 2.45      | 0.98   | 1.97  | 2.95  | 3.94  | 4.92  | 5.90  | 6.89   | 7.87   | 8.85   | 9.84   |
| 2.50      | 0.95   | 1.89  | 2.84  | 3.78  | 4.73  | 5.67  | 6.62   | 7.56   | 8.51   | 9.46   |
| 2.55      | 0.91   | 1.82  | 2.73  | 3.64  | 4.55  | 5.46  | 6.37   | 7.28   | 8.19   | 9.10   |
| 2.60      | 0.88   | 1.75  | 2.63  | 3.51  | 4.39  | 5.26  | 6.14   | 7.02   | 7.90   | 8.77   |
| 2.65      | 0.85   | 1.69  | 2.54  | 3.39  | 4.23  | 5.08  | 5.93   | 6.77   | 7.62   | 8.47   |
| 2.70      | 0.82   | 1.64  | 2.45  | 3.27  | 4.09  | 4.91  | 5.73   | 6.55   | 7.36   | 8.18   |
| 2.75      | 0.79   | 1.58  | 2.37  | 3.17  | 3.96  | 4.75  | 5.54   | 6.33   | 7.12   | 7.92   |
| 2.80      | 0.77   | 1.53  | 2.30  | 3.07  | 3.83  | 4.60  | 5.37   | 6.13   | 6.90   | 7.67   |
| 2.85      | 0.74   | 1.49  | 2.23  | 2.97  | 3.72  | 4.46  | 5.20   | 5.94   | 6.69   | 7.43   |
| 2.90      | 0.72   | 1.44  | 2.16  | 2.88  | 3.61  | 4.33  | 5.05   | 5.77   | 6.49   | 7.21   |
| 2.95      | 0.70   | 1.40  | 2.10  | 2.80  | 3.50  | 4.20  | 4.90   | 5.60   | 6.30   | 7.00   |
| 3.00      | 0.68   | 1.36  | 2.04  | 2.72  | 3.40  | 4.08  | 4.76   | 5.45   | 6.13   | 6.81   |
| 3.05      | 0.66   | 1.32  | 1.99  | 2.65  | 3.31  | 3.97  | 4.63   | 5.30   | 5.96   | 6.62   |
| 3.10      | 0.64   | 1.29  | 1.93  | 2.58  | 3.22  | 3.87  | 4.51   | 5.16   | 5.80   | 6.45   |
| 3.15      | 0.63   | 1.26  | 1.88  | 2.51  | 3.14  | 3.77  | 4.40   | 5.02   | 5.65   | 6.28   |
| 3.20      | 0.61   | 1.22  | 1.84  | 2.45  | 3.06  | 3.67  | 4.28   | 4.90   | 5.51   | 6.12   |
| 3.25      | 0.60   | 1.19  | 1.79  | 2.39  | 2.99  | 3.58  | 4.18   | 4.78   | 5.37   | 5.97   |
| 3.30      | 0.58   | 1.17  | 1.75  | 2.33  | 2.91  | 3.50  | 4.08   | 4.66   | 5.24   | 5.83   |

## External Resistor Divider Table

| R1(K Ohm) | 1  | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   |
|-----------|--|------|------|------|------|------|------|------|------|------|
| VOUT      | $R2(K\text{ Ohm})=(1.215 \cdot R1(K\text{ Ohm})) / (VOUT - 1.215)$ |      |      |      |      |      |      |      |      |      |
| 3.35      | 0.57   | 1.14 | 1.71 | 2.28 | 2.85 | 3.41 | 3.98 | 4.55 | 5.12 | 5.69 |
| 3.40      | 0.56   | 1.11 | 1.67 | 2.22 | 2.78 | 3.34 | 3.89 | 4.45 | 5.00 | 5.56 |
| 3.45      | 0.54   | 1.09 | 1.63 | 2.17 | 2.72 | 3.26 | 3.81 | 4.35 | 4.89 | 5.44 |
| 3.50      | 0.53   | 1.06 | 1.60 | 2.13 | 2.66 | 3.19 | 3.72 | 4.25 | 4.79 | 5.32 |
| 3.55      | 0.52   | 1.04 | 1.56 | 2.08 | 2.60 | 3.12 | 3.64 | 4.16 | 4.68 | 5.20 |
| 3.60      | 0.51   | 1.02 | 1.53 | 2.04 | 2.55 | 3.06 | 3.57 | 4.08 | 4.58 | 5.09 |
| 3.65      | 0.50   | 1.00 | 1.50 | 2.00 | 2.49 | 2.99 | 3.49 | 3.99 | 4.49 | 4.99 |
| 3.70      | 0.49   | 0.98 | 1.47 | 1.96 | 2.44 | 2.93 | 3.42 | 3.91 | 4.40 | 4.89 |
| 3.75      | 0.48   | 0.96 | 1.44 | 1.92 | 2.40 | 2.88 | 3.36 | 3.83 | 4.31 | 4.79 |
| 3.80      | 0.47   | 0.94 | 1.41 | 1.88 | 2.35 | 2.82 | 3.29 | 3.76 | 4.23 | 4.70 |
| 3.85      | 0.46   | 0.92 | 1.38 | 1.84 | 2.31 | 2.77 | 3.23 | 3.69 | 4.15 | 4.61 |
| 3.90      | 0.45   | 0.91 | 1.36 | 1.81 | 2.26 | 2.72 | 3.17 | 3.62 | 4.07 | 4.53 |
| 3.95      | 0.44   | 0.89 | 1.33 | 1.78 | 2.22 | 2.67 | 3.11 | 3.55 | 4.00 | 4.44 |
| 4.00      | 0.44   | 0.87 | 1.31 | 1.75 | 2.18 | 2.62 | 3.05 | 3.49 | 3.93 | 4.36 |
| 4.05      | 0.43   | 0.86 | 1.29 | 1.71 | 2.14 | 2.57 | 3.00 | 3.43 | 3.86 | 4.29 |
| 4.10      | 0.42   | 0.84 | 1.26 | 1.68 | 2.11 | 2.53 | 2.95 | 3.37 | 3.79 | 4.21 |
| 4.15      | 0.41   | 0.83 | 1.24 | 1.66 | 2.07 | 2.48 | 2.90 | 3.31 | 3.73 | 4.14 |
| 4.20      | 0.41   | 0.81 | 1.22 | 1.63 | 2.04 | 2.44 | 2.85 | 3.26 | 3.66 | 4.07 |
| 4.25      | 0.40   | 0.80 | 1.20 | 1.60 | 2.00 | 2.40 | 2.80 | 3.20 | 3.60 | 4.00 |
| 4.30      | 0.39   | 0.79 | 1.18 | 1.58 | 1.97 | 2.36 | 2.76 | 3.15 | 3.54 | 3.94 |
| 4.35      | 0.39   | 0.78 | 1.16 | 1.55 | 1.94 | 2.33 | 2.71 | 3.10 | 3.49 | 3.88 |
| 4.40      | 0.38   | 0.76 | 1.14 | 1.53 | 1.91 | 2.29 | 2.67 | 3.05 | 3.43 | 3.81 |
| 4.45      | 0.38   | 0.75 | 1.13 | 1.50 | 1.88 | 2.25 | 2.63 | 3.00 | 3.38 | 3.76 |
| 4.50      | 0.37   | 0.74 | 1.11 | 1.48 | 1.85 | 2.22 | 2.59 | 2.96 | 3.33 | 3.70 |
| 4.55      | 0.36   | 0.73 | 1.09 | 1.46 | 1.82 | 2.19 | 2.55 | 2.91 | 3.28 | 3.64 |
| 4.60      | 0.36   | 0.72 | 1.08 | 1.44 | 1.79 | 2.15 | 2.51 | 2.87 | 3.23 | 3.59 |
| 4.65      | 0.35   | 0.71 | 1.06 | 1.41 | 1.77 | 2.12 | 2.48 | 2.83 | 3.18 | 3.54 |
| 4.70      | 0.35   | 0.70 | 1.05 | 1.39 | 1.74 | 2.09 | 2.44 | 2.79 | 3.14 | 3.49 |
| 4.75      | 0.34   | 0.69 | 1.03 | 1.37 | 1.72 | 2.06 | 2.41 | 2.75 | 3.09 | 3.44 |
| 4.80      | 0.34   | 0.68 | 1.02 | 1.36 | 1.69 | 2.03 | 2.37 | 2.71 | 3.05 | 3.39 |
| 4.85      | 0.33   | 0.67 | 1.00 | 1.34 | 1.67 | 2.01 | 2.34 | 2.67 | 3.01 | 3.34 |
| 4.90      | 0.33   | 0.66 | 0.99 | 1.32 | 1.65 | 1.98 | 2.31 | 2.64 | 2.97 | 3.30 |
| 4.95      | 0.33   | 0.65 | 0.98 | 1.30 | 1.63 | 1.95 | 2.28 | 2.60 | 2.93 | 3.25 |
| 5.00      | 0.32   | 0.64 | 0.96 | 1.28 | 1.61 | 1.93 | 2.25 | 2.57 | 2.89 | 3.21 |

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