



# SGM820xQ

## High-Accuracy Supervisory Circuit with Programmable Watchdog Timer for Automotive Applications

### GENERAL DESCRIPTION

The SGM820xQ is a family of high-accuracy supervisory circuits with programmable watchdog timer. It provides three under-voltage threshold voltage options of 1.674V, 2.325V, 3.069V and 4.650V (TYP) for 1.8V, 2.5V, 3.3V and 5V system rail voltage monitoring. Besides, the nRESET delay of the SGM820xQ has a high-precision delay timing. And combined with its accurate voltage monitoring hysteresis, the SGM820xQ is very suitable for strict tolerance systems.

The SGM820xQ has a programmable watchdog timer. Users can program the timeouts through an external capacitor or take the default factory settings. In addition, users can disable the watchdog through logic pins to prevent accidental timeouts during development.

The device is AEC-Q100 qualified (Automotive Electronics Council (AEC) standard Q100 Grade 1) and it is suitable for automotive applications.

The SGM820xQ is available in Green TDFN-3×3-8GL and TDFN-2×2-8DL packages. It operates over an ambient temperature range of -40°C to +125°C.

### TYPICAL APPLICATION

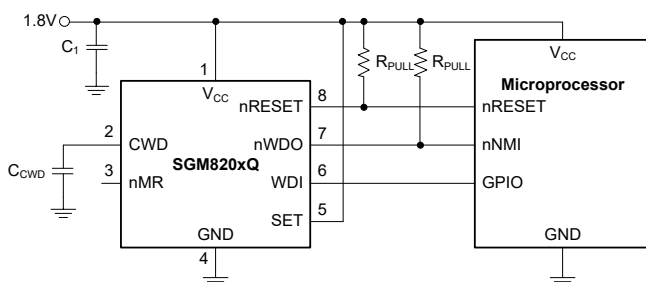


Figure 1. Typical Application Circuit

### FEATURES

- **AEC-Q100 Qualified for Automotive Applications**  
**Device Temperature Grade 1**  
 $T_A = -40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- **Precision Fixed Detection Options:**
  - ♦  $V_{ITN} = 1.674\text{V}$  (TYP) for 1.8V System
  - ♦  $V_{ITN} = 2.325\text{V}$  (TYP) for 2.5V System
  - ♦  $V_{ITN} = 3.069\text{V}$  (TYP) for 3.3V System
  - ♦  $V_{ITN} = 4.650\text{V}$  (TYP) for 5V System
- **High-Accuracy Voltage Threshold ( $< 1.2\%$ )**
- **Hysteresis Characteristics: 0.5% (TYP)**
- **Supply Voltage Range: 1.6V to 6.5V**
- **Ultra-Low Supply Current: 1.2μA (TYP)**
- **High-Accuracy Reset Delay**
- **nRESET Delay Time and Watchdog Active Time:**
  - ♦ **SGM820A/B-xQ: 200ms (TYP)**
  - ♦ **SGM820C/D-xQ: 25ms (TYP)**
- **High-Accuracy User-Programmable Watchdog Timer:**
  - ♦ **Standard Version: SGM820A/C-xQ**
  - ♦ **Extended Version: SGM820B/D-xQ**
- **Watchdog Disable Function**
- **Available Manual Reset Input (nMR)**
- **Open-Drain nRESET Output**
- **Available in Green TDFN-3×3-8GL and TDFN-2×2-8DL Packages**

### APPLICATIONS

Safety Applications  
Automotive Applications  
Precision Industrial System  
Controllers  
DSPs, FPGAs and ASICs

# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## PACKAGE/ORDERING INFORMATION

MODEL	UNDER-VOLTAGE THRESHOLD (V)	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM820A-4.6Q	4.650	TDFN-3×3-8GL	-40°C to +125°C	SGM820A-4.6QTGS8G/TR	187TGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820A-4.6QTGT8G/TR	183 XXXX	Tape and Reel, 3000
SGM820B-4.6Q	4.650	TDFN-3×3-8GL	-40°C to +125°C	SGM820B-4.6QTGS8G/TR	188TGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820B-4.6QTGT8G/TR	184 XXXX	Tape and Reel, 3000
SGM820C-4.6Q	4.650	TDFN-3×3-8GL	-40°C to +125°C	SGM820C-4.6QTGS8G/TR	189TGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820C-4.6QTGT8G/TR	185 XXXX	Tape and Reel, 3000
SGM820D-4.6Q	4.650	TDFN-3×3-8GL	-40°C to +125°C	SGM820D-4.6QTGS8G/TR	18ATGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820D-4.6QTGT8G/TR	186 XXXX	Tape and Reel, 3000
SGM820A-3.0Q	3.069	TDFN-3×3-8GL	-40°C to +125°C	SGM820A-3.0QTGS8G/TR	06WTGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820A-3.0QTGT8G/TR	06Y XXXX	Tape and Reel, 3000
SGM820B-3.0Q	3.069	TDFN-3×3-8GL	-40°C to +125°C	SGM820B-3.0QTGS8G/TR	06VTGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820B-3.0QTGT8G/TR	06X XXXX	Tape and Reel, 3000
SGM820C-3.0Q	3.069	TDFN-3×3-8GL	-40°C to +125°C	SGM820C-3.0QTGS8G/TR	0K9TGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820C-3.0QTGT8G/TR	0K3 XXXX	Tape and Reel, 3000
SGM820D-3.0Q	3.069	TDFN-3×3-8GL	-40°C to +125°C	SGM820D-3.0QTGS8G/TR	0KATGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820D-3.0QTGT8G/TR	0K4 XXXX	Tape and Reel, 3000
SGM820A-2.3Q	2.325	TDFN-3×3-8GL	-40°C to +125°C	SGM820A-2.3QTGS8G/TR	0H9TGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820A-2.3QTGT8G/TR	0HD XXXX	Tape and Reel, 3000
SGM820B-2.3Q	2.325	TDFN-3×3-8GL	-40°C to +125°C	SGM820B-2.3QTGS8G/TR	0HBTGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820B-2.3QTGT8G/TR	0HF XXXX	Tape and Reel, 3000

# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## PACKAGE/ORDERING INFORMATION (continued)

MODEL	UNDER-VOLTAGE THRESHOLD (V)	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM820C-2.3Q	2.325	TDFN-3×3-8GL	-40°C to +125°C	SGM820C-2.3QTGS8G/TR	0K7TGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820C-2.3QTGT8G/TR	0K1 XXXX	Tape and Reel, 3000
SGM820D-2.3Q	2.325	TDFN-3×3-8GL	-40°C to +125°C	SGM820D-2.3QTGS8G/TR	0K8TGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820D-2.3QTGT8G/TR	0K2 XXXX	Tape and Reel, 3000
SGM820A-1.6Q	1.674	TDFN-3×3-8GL	-40°C to +125°C	SGM820A-1.6QTGS8G/TR	0H8TGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820A-1.6QTGT8G/TR	0HC XXXX	Tape and Reel, 3000
SGM820B-1.6Q	1.674	TDFN-3×3-8GL	-40°C to +125°C	SGM820B-1.6QTGS8G/TR	0HATGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820B-1.6QTGT8G/TR	0HE XXXX	Tape and Reel, 3000
SGM820C-1.6Q	1.674	TDFN-3×3-8GL	-40°C to +125°C	SGM820C-1.6QTGS8G/TR	0K5TGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820C-1.6QTGT8G/TR	0JZ XXXX	Tape and Reel, 3000
SGM820D-1.6Q	1.674	TDFN-3×3-8GL	-40°C to +125°C	SGM820D-1.6QTGS8G/TR	0K6TGS XXXXXX YYYYYY	Tape and Reel, 4000
		TDFN-2×2-8DL	-40°C to +125°C	SGM820D-1.6QTGT8G/TR	0K0 XXXX	Tape and Reel, 3000

### NOTES:

1. The SGM820A/C-xQ provides standard user-programming watchdog timeout:

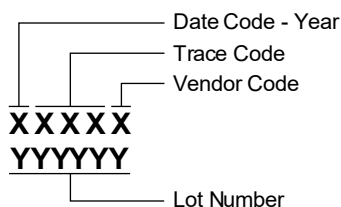
$$t_{WD\_standard} (ms) = 3.33 \times C_{CWD} (nF) + 0.28 (ms)$$

2. The SGM820B/D-xQ provides extended user-programming watchdog timeout:

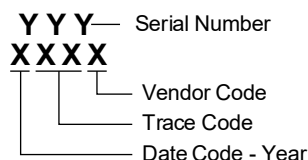
$$t_{WD\_extended} (ms) = 78.3 \times C_{CWD} (nF) + 51 (ms)$$

## MARKING INFORMATION

### TDFN-3×3-8GL



### TDFN-2×2-8DL



Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage Range, $V_{CC}$ .....	-0.3V to 7V
Output Voltage Range nRESET, nWDO .....	-0.3V to 7V
Voltage Ranges SET, WDI, nMR.....	-0.3V to 7V
CWD.....	-0.3V to $V_{CC} + 0.3V$
Output Pin Current nRESET, nWDO .....	$\pm 20mA$
Package Thermal Resistance TDFN-3x3-8GL, $\theta_{JA}$ .....	72°C/W
TDFN-3x3-8GL, $\theta_{JB}$ .....	44°C/W
TDFN-3x3-8GL, $\theta_{JC(TOP)}$ .....	75°C/W
TDFN-3x3-8GL, $\theta_{JC(BOT)}$ .....	32.3°C/W
TDFN-2x2-8DL, $\theta_{JA}$ .....	86°C/W
TDFN-2x2-8DL, $\theta_{JB}$ .....	53°C/W
TDFN-2x2-8DL, $\theta_{JC(TOP)}$ .....	104°C/W
TDFN-2x2-8DL, $\theta_{JC(BOT)}$ .....	33.6°C/W
Junction Temperature.....	+150°C
Storage Temperature Range .....	-65°C to +150°C
Lead Temperature (Soldering, 10s).....	+260°C
ESD Susceptibility HBM.....	$\pm 4000V$
CDM .....	$\pm 1000V$

### NOTES:

1. For human body model (HBM), all pins comply with AEC-Q100-002 specification.
2. For charged device model (CDM), all pins comply with AEC-Q100-011 specification.

## RECOMMENDED OPERATING CONDITIONS

Supply Pin Voltage, $V_{CC}$ .....	1.6V to 6.5V
SET Pin Voltage, $V_{SET}$ .....	0V to 6.5V
Watchdog Timing Capacitor, $C_{CWD}$ .....	0.1nF to 1000nF <sup>(1)</sup>
Pull-Up Resistor to $V_{CC}$ , $R_{CWD}$ .....	9k $\Omega$ to 11k $\Omega$
Pull-Up Resistor, nRESET and nWDO, $R_{PULL}$ .....	1k $\Omega$ to 100k $\Omega$
nRESET Pin Current, $I_{nRESET}$ .....	10mA
Watchdog Output Current, $I_{nWDO}$ .....	10mA
Operating Junction Temperature Range.....	-40°C to +125°C

### NOTE:

1. It is recommended to use the standard timing with a  $C_{CWD}$  capacitor from 0.1nF to 1000nF, and it offers  $t_{WD\_TYP}$  from 0.613ms to 3.33s accordingly. If using extended timing, it offers  $t_{WD\_TYP}$  from 58.83ms to 78.35s accordingly.

## OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

## ESD SENSITIVITY CAUTION

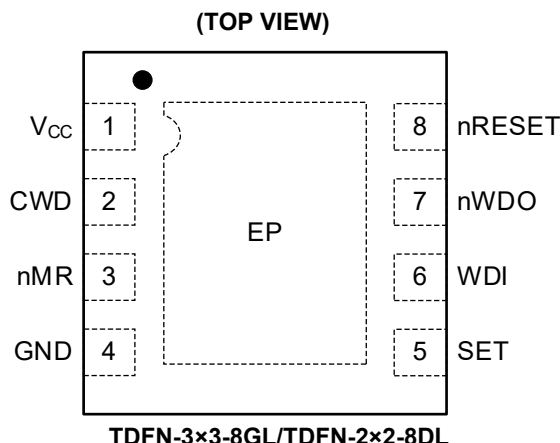
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

## DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## PIN CONFIGURATIONS



## PIN DESCRIPTION

PIN	NAME	TYPE	FUNCTION
1	V <sub>CC</sub>	I	Supply Voltage Pin. It is recommended to place a 0.1μF ceramic capacitor close to this pin.
2	CWD	I	Programmable Watchdog Timeout Input Pin. Connecting the CWD pin to GND via a capacitor to set the adjustable watchdog timeout. Connecting the CWD pin to V <sub>CC</sub> via a 10kΩ resistor or leaving it unconnected to select two different kinds of the preset watchdog timeout.
3	nMR	I	Manual Reset Input Pin. It is an active-low reset input with internal pull-up current.
4	GND	G	Ground.
5	SET	I	Logic Input Pin. Connecting the SET pin to GND will disable the watchdog timer. If nRESET is deasserted, the watchdog can be enabled when SET is high.
6	WDI	I	Watchdog Input Pin. The WDI falling edge must appear within the timeout (t <sub>WD</sub> ) period. When nWDO or nRESET is low and the watchdog is disabled, WDI will be ignored. Note that this pin cannot be left floating.
7	nWDO	O	Watchdog Open-Drain Output Pin. It is recommended to connect a resistor from 1kΩ to 10kΩ to the rail. If the watchdog timeout occurs, the nWDO goes low for an nRESET timeout delay (t <sub>RST</sub> ).
8	nRESET	O	Active-Low Open-Drain Reset Output Pin. It is recommended to connect a resistor from 1kΩ to 10kΩ to the rail. nRESET remains low if V <sub>CC</sub> is below the under-voltage threshold (V <sub>ITN</sub> ). And it goes high when V <sub>CC</sub> exceeds V <sub>ITN</sub> + V <sub>HYS</sub> after nRESET delay time (t <sub>RST</sub> ).
Exposed Pad	EP	G	Exposed Pad. This pad is not connected to internal circuit.

NOTE: I: Input; O: Output; G: Ground.

# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## ELECTRICAL CHARACTERISTICS

( $V_{ITN} + V_{HYS} \leq V_{CC} \leq 6.5V$ ,  $R_{PULL} = 10k\Omega$ ,  $T_J = -40^\circ C$  to  $+125^\circ C$ , typical values are measured at  $T_J = +25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>General Characteristics</b>						
Power Supply Voltage <sup>(1) (2)</sup>	$V_{CC}$		1.6		6.5	V
Supply Current	$I_{CC}$			1.2	3.3	$\mu A$
<b>Reset Function</b>						
Power-On Reset Voltage <sup>(1)</sup>	$V_{POR}$	$I_{nRESET} = 15\mu A$ , $V_{OL(MAX)} = 0.25V$			0.8	V
Under-Voltage Threshold	$V_{ITN}$	SGM820x-4.6Q, $V_{CC}$ falling	4.600	4.650	4.700	V
		SGM820x-3.0Q, $V_{CC}$ falling	3.033	3.069	3.099	
		SGM820x-2.3Q, $V_{CC}$ falling	2.298	2.325	2.349	
		SGM820x-1.6Q, $V_{CC}$ falling	1.654	1.674	1.691	
Hysteresis Voltage	$V_{HYS}$	$V_{CC}$ rising	$0.15\% \times V_{ITN}$	$0.50\% \times V_{ITN}$	$0.85\% \times V_{ITN}$	V
nMR Pin Internal Pull-Up Current	$I_{nMR}$	$V_{nMR} = 0V$	520	620	720	nA
<b>Watchdog Function</b>						
CWD Pin Charging Current	$I_{CWD}$	CWD = 0.5V	337	375	413	nA
CWD Pin Threshold Voltage	$V_{CWD}$		1.180	1.210	1.245	V
nRESET, nWDO Output Low	$V_{OL}$	$V_{CC} = 5V$ , $I_{SINK} = 3mA$			0.4	V
nRESET, nWDO Output Leakage Current, Open-Drain	$I_D$	$V_{CC} = V_{ITN} + V_{HYS}$ , $V_{nRESET} = V_{nWDO} = 6.5V$			1	$\mu A$
Low-Level Input Voltage of nMR	$V_{IL\_nMR}$				0.25	V
High-Level Input Voltage of nMR	$V_{IH\_nMR}$		0.8			V
Low-Level Input Voltage of SET	$V_{IL\_SET}$				0.25	V
High-Level Input Voltage of SET	$V_{IH\_SET}$		0.8			V
Low-Level Input Voltage of WDI	$V_{IL\_WDI}$				$0.3 \times V_{CC}$	V
High-Level Input Voltage of WDI	$V_{IH\_WDI}$		$0.8 \times V_{CC}$			V

### NOTES:

1. When  $V_{CC}$  is lower than  $V_{POR}$ , nRESET and nWDO are not defined.
2. During power-on,  $V_{CC}$  must be 1.6V (MIN) for at least 400 $\mu s$  before nRESET correlates with  $V_{CC}$ .

# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## TIMING REQUIREMENTS

( $V_{ITN} + V_{HYS} \leq V_{CC} \leq 6.5V$ ,  $R_{PULL} = 10k\Omega$ ,  $T_J = -40^\circ C$  to  $+125^\circ C$ , typical values are measured at  $T_J = +25^\circ C$ , unless otherwise noted.)

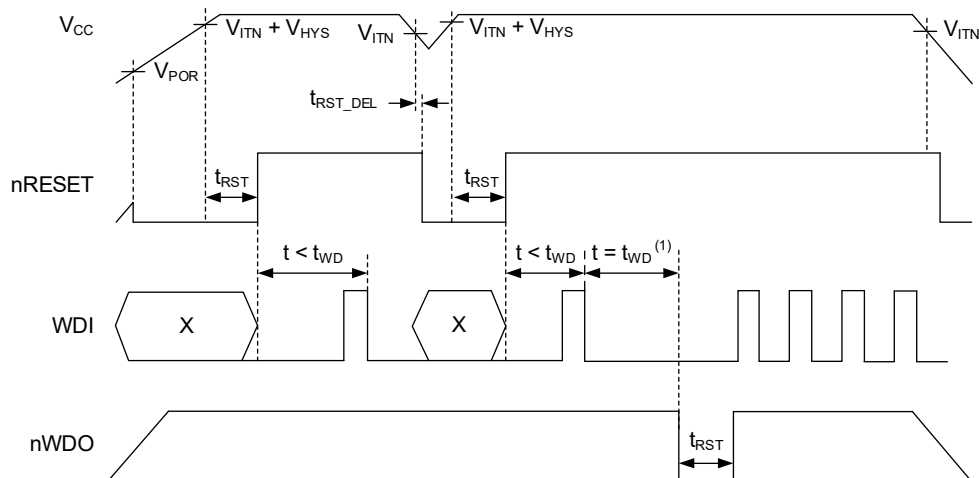
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>General</b>						
CWD Pin Evaluation Period	$t_{INIT}$			390		$\mu s$
Minimum nMR, SET Pin Pulse Duration				1		$\mu s$
<b>Reset Function</b>						
nRESET Delay Time	$t_{RST}$	SGM820A/B-xQ	170	200	230	ms
		SGM820C/D-xQ	21.25	25	28.75	
$V_{CC}$ to nRESET Delay	$t_{RST\_DEL}$	$V_{CC} = (V_{ITN} + V_{HYS}) \times (1 + 2.5\%)$ to $V_{ITN} \times (1 - 2.5\%)$		90		$\mu s$
nMR to nRESET Delay	$t_{MR\_DEL}$			700		ns
<b>Watchdog Function</b>						
Watchdog Timeout <sup>(1)</sup>	$t_{WD}$	CWD = NC, SET = 0 <sup>(2)</sup>	Watchdog disabled			
		CWD = NC, SET = 1 <sup>(2)</sup>	1360	1600	1840	ms
		CWD = 10k $\Omega$ to $V_{CC}$ , SET = 0 <sup>(2)</sup>	Watchdog disabled			
		CWD = 10k $\Omega$ to $V_{CC}$ , SET = 1 <sup>(2)</sup>	170	200	230	ms
Set-Up Time Required for Device to Respond to Changes on WDI after Being Enabled	$t_{WD\_SETUP}$			140		$\mu s$
Minimum WDI Pin Pulse Duration				50		ns
WDI to nWDO Delay	$t_{WD\_DEL}$			100		ns

### NOTES:

1. The fixed watchdog timing covers both standard version and extended version.
2. SET = 0 means  $V_{SET} < V_{IL\_SET}$ . SET = 1 means  $V_{SET} > V_{IH\_SET}$ .

# SGM820xQ High-Accuracy Supervisory Circuit with Integrated Watchdog Timer for Automotive Applications

## TIMING DIAGRAM



NOTE:

1. See Figure 3 for WDI timing requirements.

Figure 2. Timing Diagram

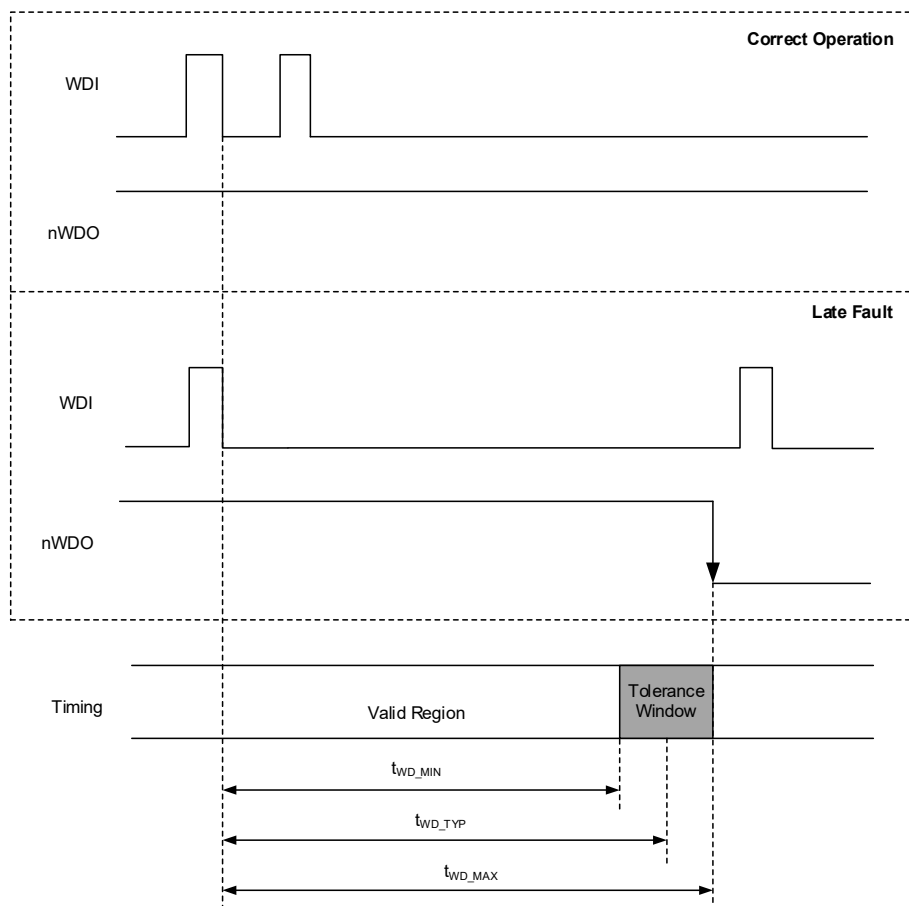


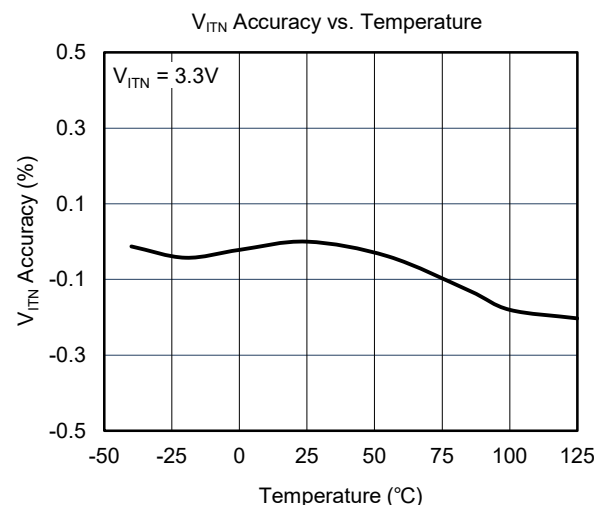
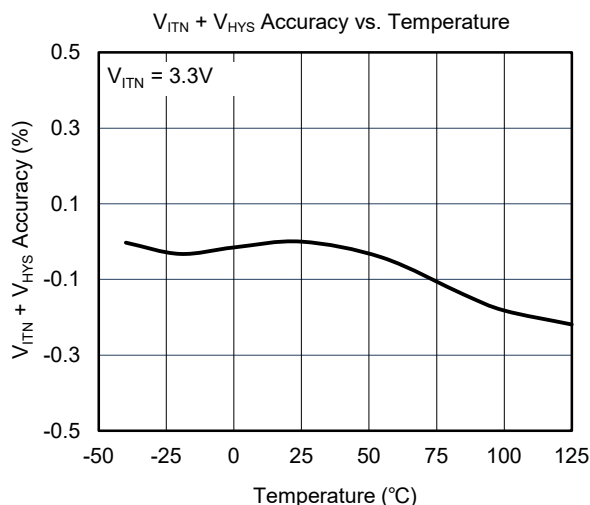
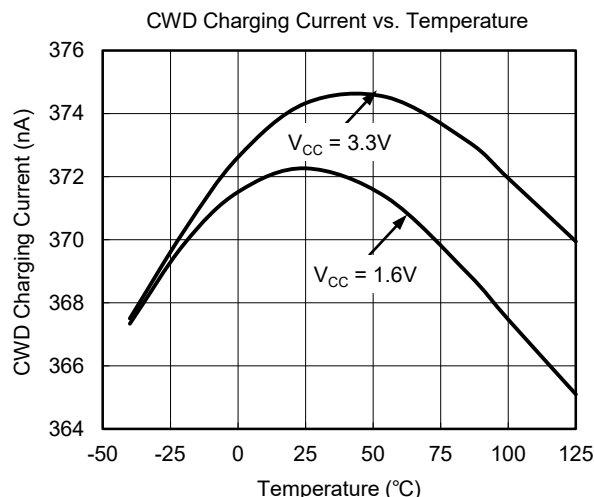
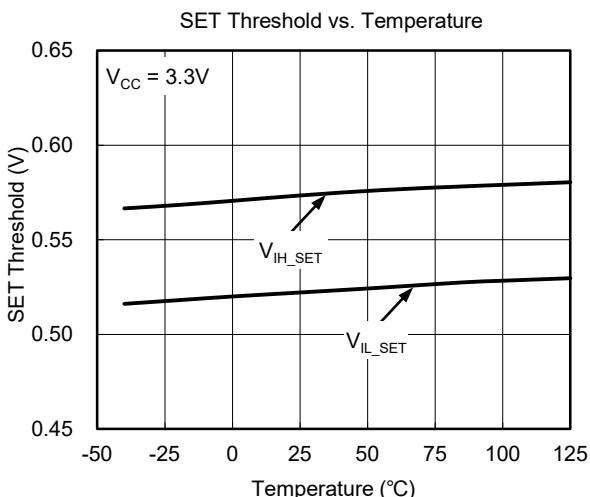
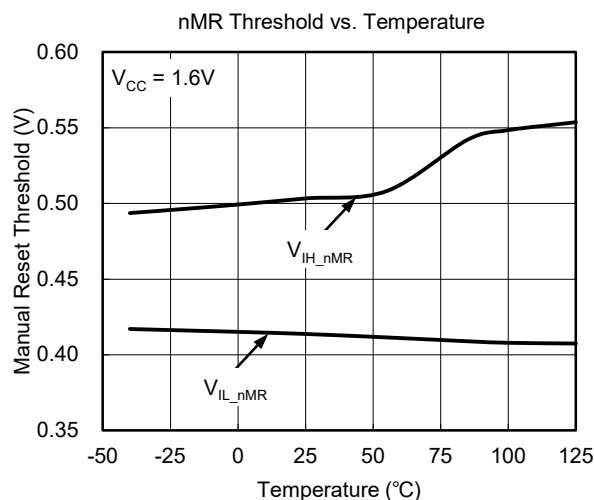
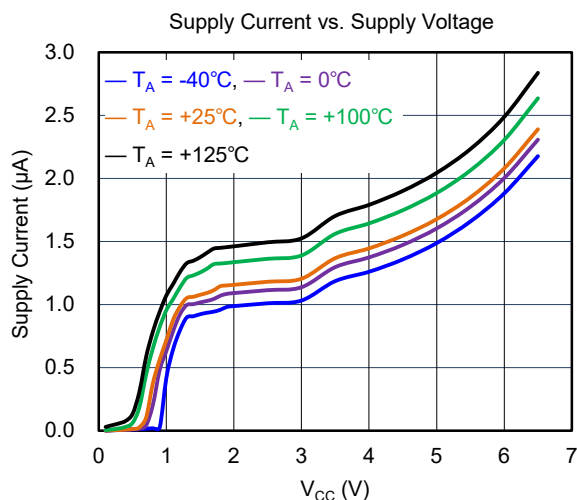
Figure 3. Watchdog Timing Diagram



# SGM820xQ High-Accuracy Supervisory Circuit with Integrated Watchdog Timer for Automotive Applications

## TYPICAL PERFORMANCE CHARACTERISTICS

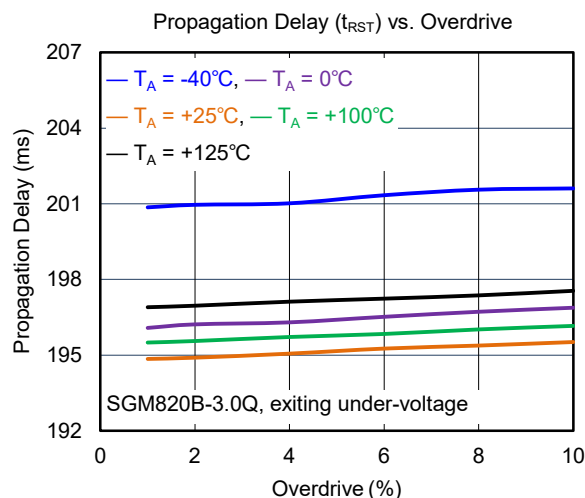
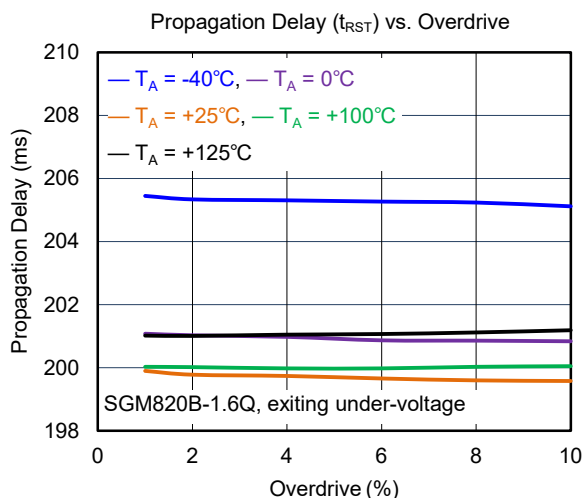
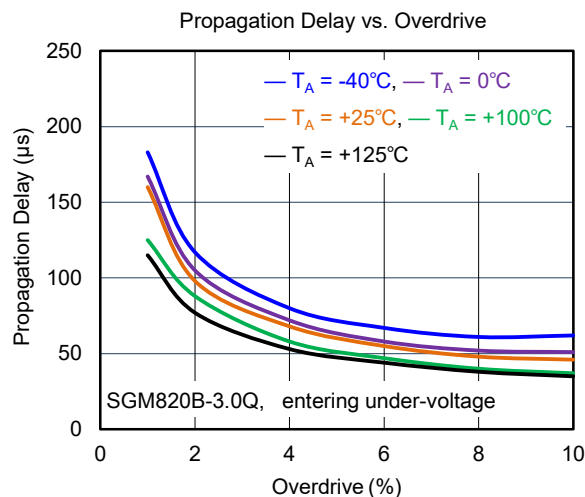
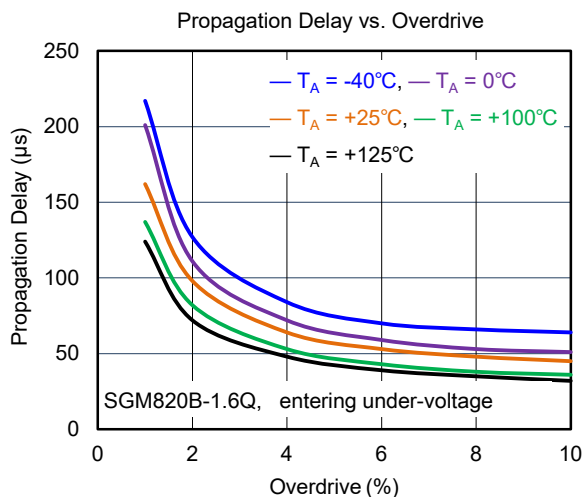
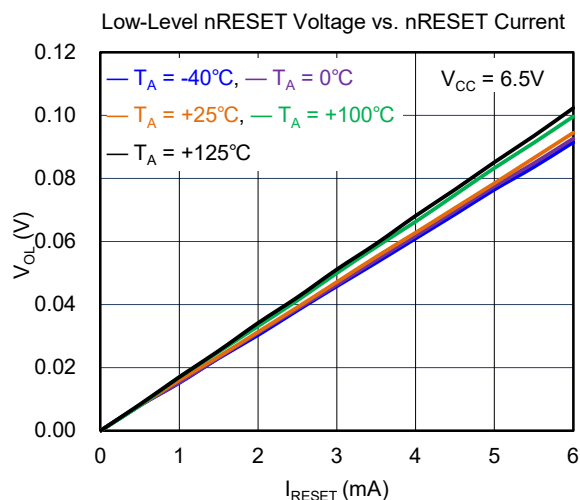
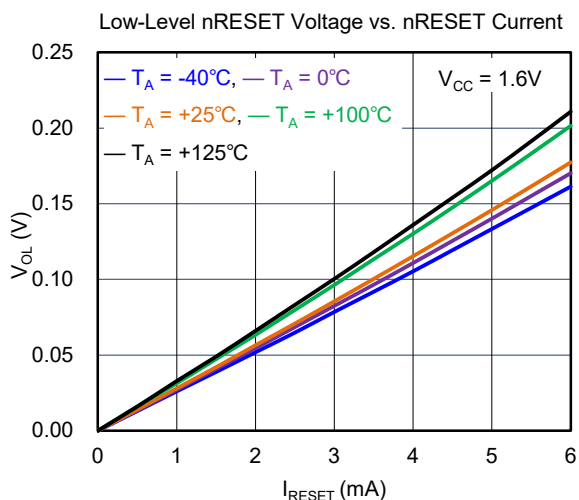
At  $T_A = +25^\circ\text{C}$ ,  $1.6\text{V} \leq V_{CC} \leq 6.5\text{V}$ , unless otherwise noted.



# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

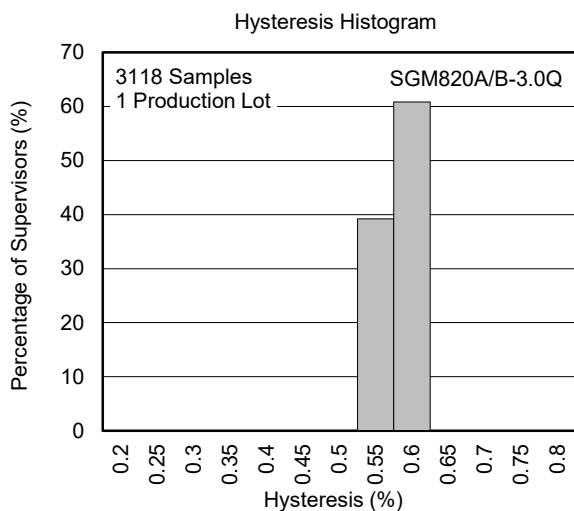
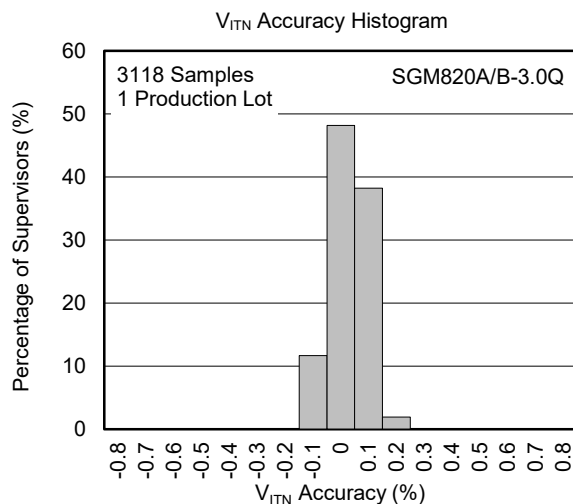
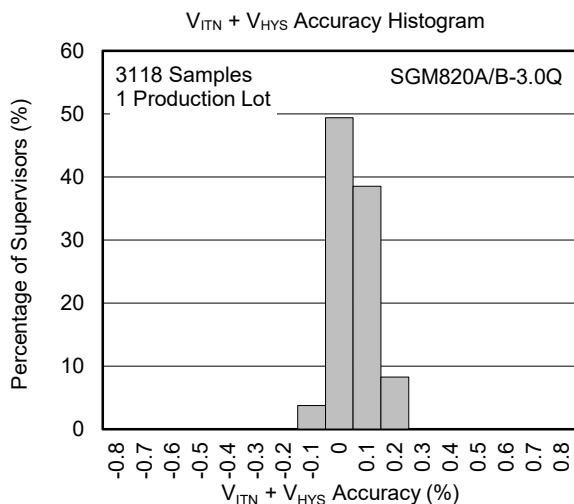
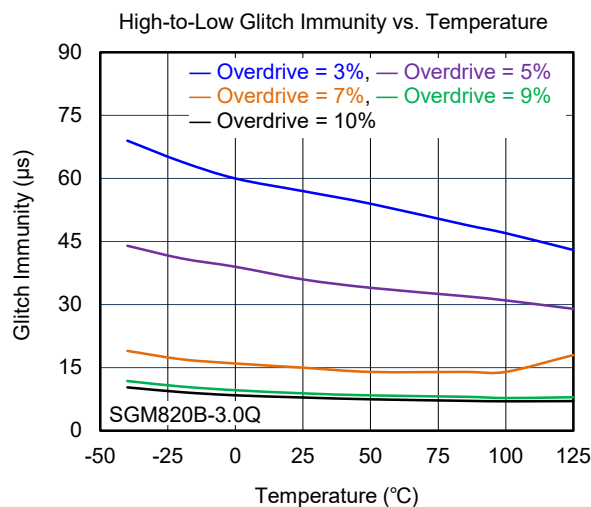
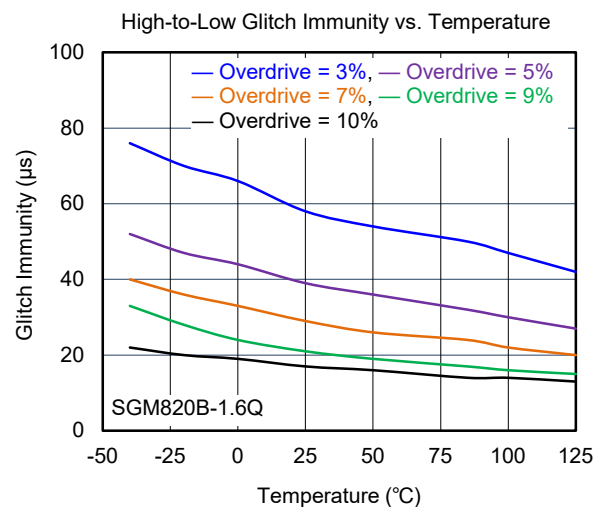
At  $T_A = +25^\circ\text{C}$ ,  $1.6\text{V} \leq V_{CC} \leq 6.5\text{V}$ , unless otherwise noted.



# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $1.6\text{V} \leq V_{CC} \leq 6.5\text{V}$ , unless otherwise noted.



# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## FUNCTIONAL BLOCK DIAGRAM

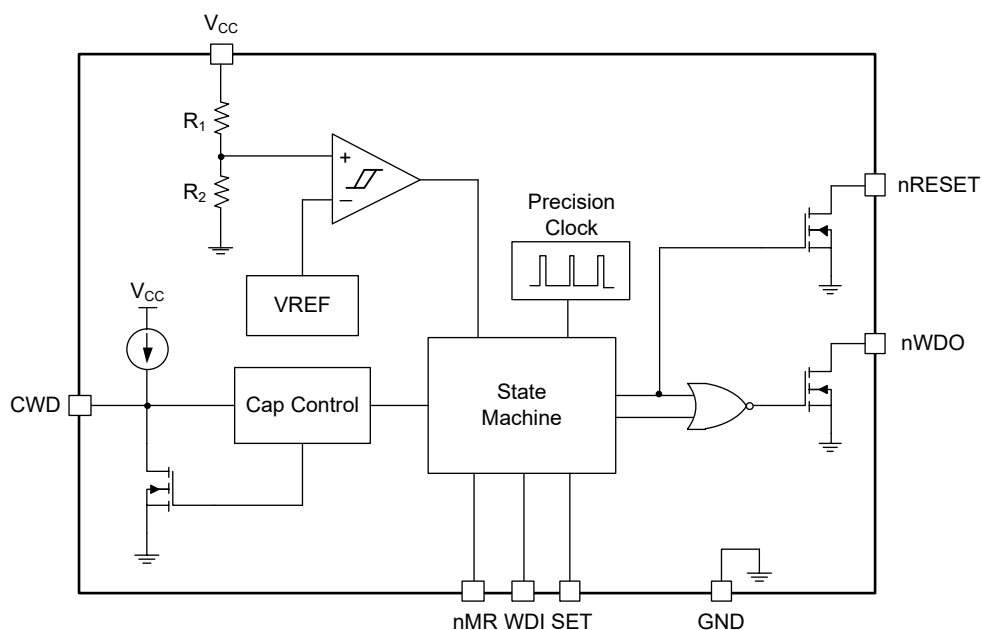


Figure 4. SGM820xQ Block Diagram

# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## DETAILED DESCRIPTION

### Overview

The SGM820xQ is a high-precision voltage supervisor, integrated with an accurate watchdog timer in the specified temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . Besides, it ensures an accurate hysteresis on the threshold, which makes it very suitable for systems that need small tolerance. And two options are provided to set the watchdog timing: a standard version and an extended one.

### nRESET

The nRESET is an open-drain output pin, and users should connect the nRESET pin to  $V_{CC}$  or another voltage rail through a pull-up resistor of  $1\text{k}\Omega$  to  $100\text{k}\Omega$ . Once  $V_{CC}$  falls below the under-voltage threshold ( $V_{ITN}$ ), the nRESET is asserted to be low. And if  $V_{CC}$  exceeds  $V_{ITN} + V_{HYS}$ , the nRESET will keep low for a specified reset delay time ( $t_{RST}$ ). And then, the nRESET pin goes high with the pull-up resistor. Users should carefully consider the factors such as capacitive loading, logic low output voltage ( $V_{OL}$ ), leakage current ( $I_D$ ) and the current through the nRESET pin ( $I_{nRESET}$ ) to select appropriate resistance values. It ensures that the high and low output voltage values meet the requirements of subsequent applications.

### Manual Reset (nMR)

The manual reset input (nMR) is logic low effective, and it can be used to initiate a reset by a processor or some other logic circuits. The nRESET is deasserted after  $t_{RST}$  if nMR becomes high and  $V_{CC}$  is above  $V_{ITN} + V_{HYS}$ . Knowing that the nMR pin is pulled up internally, connect nMR to  $V_{CC}$  or just leave it floating once it is unnecessary to control it externally.

### Under-Voltage Detection

The SGM820xQ provide three under-voltage threshold voltage options of 1.674V, 2.325V, 3.069V and 4.650V (TYP), which are suitable for 1.8V, 2.5V, 3.3V and 5V system rail voltage monitoring. As is shown in Figure 5, when  $V_{CC}$  is below  $V_{ITN}$ , the nRESET is asserted and remains low. And when  $V_{CC}$  is higher than  $V_{ITN} + V_{HYS}$ , the nRESET deasserts after  $t_{RST}$ .

The hysteresis of the built-in comparator can immune some noise of the system. However, it is strongly recommended to place a bypass capacitor of  $0.1\mu\text{F}$  to

$100\text{nF}$  near the  $V_{CC}$  pin to immune the transient voltage and ensure stable operation.

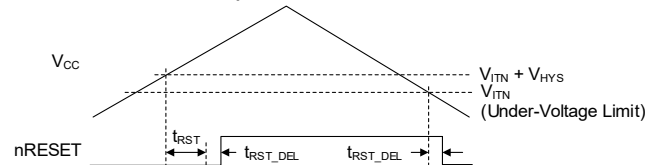


Figure 5. Under-Voltage Detection

### Watchdog Mode

Details about the principles of the watchdog mode are provided in this part.

#### CWD

Through the CWD pin, users can obtain a high-precision and preset watchdog timing in factory or a programmed one. There are three options of the SGM820xQ to configure the watchdog timer. Keep CWD pin floating or pull up a  $10\text{k}\Omega$  resistor to  $V_{CC}$  to set two different factory-programmed timers. Connect a capacitor between the CWD pin and GND to achieve an adjustable timer. Every time when  $V_{CC}$  exceeds the  $V_{ITN} + V_{HYS}$ , the device checks the CWD configuration state within  $t_{INIT}$  (about  $390\mu\text{s}$ , TYP). During this time, an internal state machine is used to check the CWD pin state and lock it out until nRESET is asserted or powered off.

#### Watchdog Input (WDI)

The WDI pin is the falling-edge triggered watchdog timer input pin. The WDI pulse should be sent out within  $t_{WD\_MIN}$ , and the pulse of WDI should be at least larger than 50ns to ensure that the pulse can be detected by the device. If a valid WDI is received, the nWDO remains deasserted. If not, the nWDO is asserted to be low.

The WDI is a logic input pin and it cannot be left floating. Users should drive WDI to either  $V_{CC}$  or GND to avoid the increasing current of the supply current. When nRESET is asserted, the watchdog function is disabled and any signals cannot be recognized by the device. When nRESET is deasserted, the device operates normally and the WDI signals can be recognized. Figure 6 shows that a valid WDI pulse can prevent nWDO from being triggered low.

# High-Accuracy Supervisory Circuit with SGM820xQ Integrated Watchdog Timer for Automotive Applications

## DETAILED DESCRIPTION (continued)

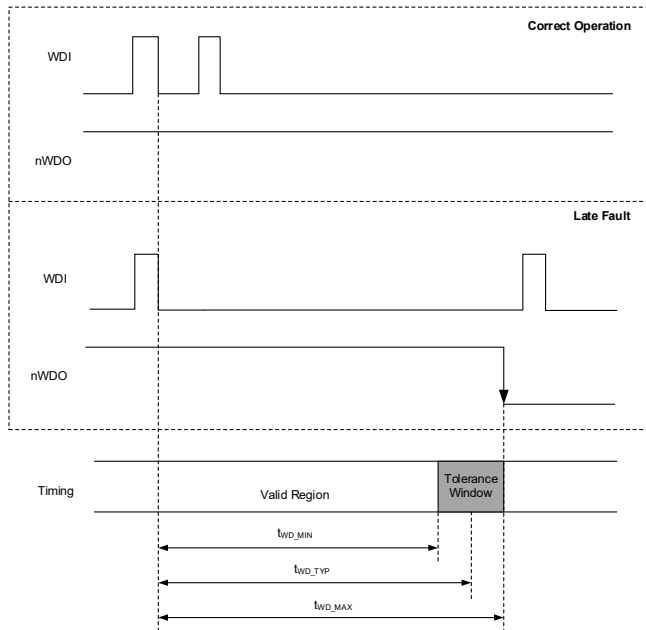


Figure 6. Watchdog Timing Diagram

### Watchdog Output (nWDO)

The nWDO is the independent watchdog output pin, and it can issue a fault flag in the watchdog timing with no need to trigger an nRESET signal, which is always used to reset the whole system. When nRESET is deasserted, the nWDO keeps normal operation and it asserts to be low for  $t_{RST}$  if no valid WDI is triggered within the valid watchdog timing region. And when the nRESET signal is asserted by some other reasons, the nWDO pin goes high if a resistor is connected to  $V_{CC}$  or another rail. When the nRESET signal is deasserted again, the watchdog timer returns back to normal operation.

### SET

The watchdog timer can be enabled or disabled by the SET pin. When the SET pin is connected to GND, the watchdog timer is disabled and signals in WDI are not recognized. Once the watchdog timer is disabled, connect WDI to  $V_{CC}$  or GND to prevent any increase of  $I_{CC}$ . When the SET pin is set to logic high, and if nRESET is not asserted, the watchdog operates properly. The SET pin is permitted to continuously change the value. However, as shown in Figure 7, there is a 140 $\mu$ s (TYP) time for the set-up of watchdog if the watchdog runs from disabled to enabled. During this period, no response can be detected on WDI by the watchdog.

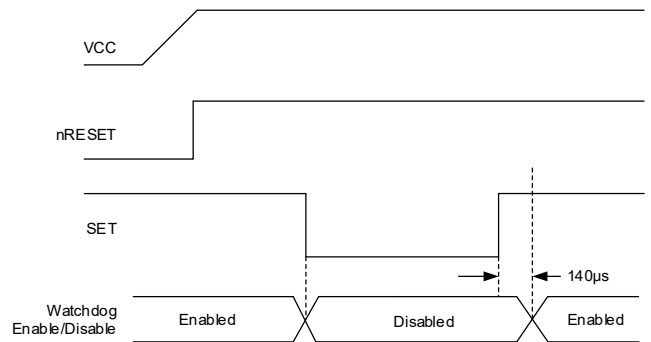


Figure 7. Enable/Disable the Watchdog

## Device Functional Modes

The functional modes of the SGM820xQ are shown in Table 1.

Table 1. Device Functional Modes

$V_{CC}$	WDI	nWDO	nRESET
$V_{CC} < V_{POR}$	---	---	Undefined
$V_{POR} \leq V_{CC} < V_{CC\_MIN}$	Ignored	High	Low
$V_{CC\_MIN} \leq V_{CC} \leq V_{ITN} + V_{HYS}$ <sup>(1)</sup>	Ignored	High	Low
$V_{CC} > V_{ITN}$ <sup>(2)</sup>	$t_{PULSE} < t_{WD\_MIN}$ <sup>(3)</sup>	High	High
$V_{CC} > V_{ITN}$ <sup>(2)</sup>	$t_{PULSE} > t_{WD\_MIN}$ <sup>(3)</sup>	Low	High

### NOTES:

1. Only valid before  $V_{CC}$  exceeds  $V_{ITN} + V_{HYS}$ .
2. Only valid after  $V_{CC}$  exceeds  $V_{ITN} + V_{HYS}$ .
3.  $t_{PULSE}$  is the time between two falling edges on WDI.

### $V_{CC}$ is below $V_{POR}$ ( $V_{CC} < V_{POR}$ )

When  $V_{CC}$  is below  $V_{POR}$ , the nRESET is not defined, which can be either logic high or logic low. At this time, the state of nRESET is greatly determined by the load floating across the nRESET pin.

### Between Power-On-Reset and $V_{CC\_MIN}$ ( $V_{POR} \leq V_{CC} < V_{CC\_MIN}$ )

When  $V_{POR} \leq V_{CC} < V_{CC\_MIN}$ , the nRESET signal is asserted to logic low and the nWDO will turn into a high-impedance state regardless of the WDI signal.

### Normal Operation ( $V_{CC} \geq V_{CC\_MIN}$ )

When  $V_{CC}$  is above or equal to  $V_{CC\_MIN}$ , the nRESET signal is determined by  $V_{CC}$ . When the nRESET is asserted, the nWDO turns to a high-impedance state and then the nWDO is pulled high through the pull-up resistor.

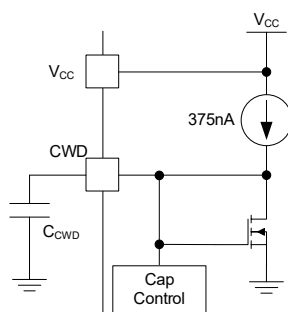
# SGM820xQ High-Accuracy Supervisory Circuit with Integrated Watchdog Timer for Automotive Applications

## APPLICATION INFORMATION

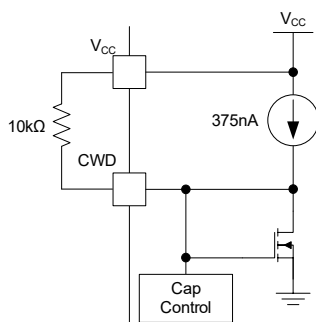
According to the eventual application requirements, the way to properly implement the device will be detailedly described in the following.

### CWD Functionality

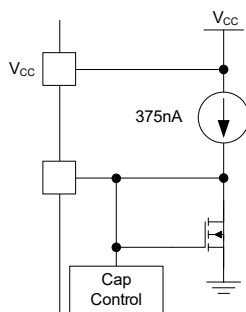
Figure 8 shows the schematic circuits of three options of the SGM820xQ to configure the watchdog timer. If connecting a 10kΩ pull-up resistor between CWD and V<sub>CC</sub> or leave CWD floating (high-impedance), the factory-set watchdog timeouts are enabled, which can be seen from Table 2. Connect the capacitor between CWD and GND to set watchdog timing period using Equation 1 and 2.



a) User-Programmable Capacitor to GND



b) 10kΩ Resistor to VCC



c) CWD Unconnected

Figure 8. CWD Charging Circuit

### Factory-Set Timing Options

As listed in Table 2, if the factory-set timing options are used, the CWD pin must be left floating or pull a 10kΩ resistor to V<sub>CC</sub>.

Table 2. Factory-Set Watchdog Timing

Input		Standard and Extended Timing WDT (t <sub>WD</sub> )		
CWD	SET	MIN	TYP	MAX
NC	0	Watchdog disabled		
NC	1	1360ms	1600ms	1840ms
10kΩ to V <sub>CC</sub>	0	Watchdog disabled		
10kΩ to V <sub>CC</sub>	1	170ms	200ms	230ms

### Adjustable Capacitor Timing

Capacitor timing can be adjusted by connecting the capacitor to the CWD pin, then a constant-current source of 375nA (TYP) begins to charge C<sub>CWD</sub> until V<sub>CWD</sub> = 1.210V (TYP). The watchdog timeout of SGM820xQ can be calculated as Equations 1 and 2, where C<sub>CWD</sub> is in nF and t<sub>WD</sub> is in ms.

For standard versions:

$$t_{WD\_standard} (ms) = 3.33 \times C_{CWD} (nF) + 0.28 (ms) \quad (1)$$

For extended versions:

$$t_{WD\_extended} (ms) = 78.3 \times C_{CWD} (nF) + 51 (ms) \quad (2)$$

The capacitors C<sub>CWD</sub> used for design and test of the SGM820xQ should be between 100pF and 1μF. And Equations 1 and 2 are only accurate for ideal capacitors. Once the capacitor tolerances are considered, the obtained watchdog timeout may vary from the preset value. It is recommended using ceramic capacitors with C0G dielectric material to achieve higher accuracy. When a C<sub>CWD</sub> capacitor is used, use Equation 1 to set t<sub>WD</sub> for standard timing and use Equation 2 to set t<sub>WD</sub> for extended timing.

## APPLICATION INFORMATION (continued)

### Overdrive Voltage

Enabling the nRESET depends on the following two factors. One factor is that the  $V_{CC}$  amplitude is above the trip point ( $\Delta V_1$  and  $\Delta V_2$ ), and the other factor is that the time length that the voltage is above the trip point ( $t_1$  and  $t_2$ ).

When  $V_{CC}$  is lower than the trip point for a long time, then the nRESET is asserted and the output is pulled low. When  $V_{CC}$  is just a few nanosecond lower than the trip point, the nRESET does not assert and the output continues to be high. Alter the time length that asserts the nRESET by increasing the proportion where  $V_{CC}$  is lower than the trip point. For example, when  $V_{CC}$  is 10% lower than the trip point, the comparator responds much faster and the nRESET is asserted much quicker than when just below the trip point voltage. Calculation of the percentage overdrive is shown in Equation 3.

$$\text{Overdrive} = |(V_{CC}/V_{ITX} - 1) \times 100\%| \quad (3)$$

Where  $V_{ITX}$  is the trip point voltage of the threshold. If  $V_{CC}$  is higher than the positive threshold, use  $V_{ITN} + V_{HYS}$  as  $V_{ITX}$ . If  $V_{CC}$  is lower than the under-voltage threshold, then  $V_{ITN}$  is considered. In Figure 9,  $t_1$  and  $t_2$  represent the period of time that  $V_{CC}$  is above or below the threshold, separately. And the propagation delay

versus overdrive for  $V_{ITN}$  and  $V_{ITN} + V_{HYS}$  is illustrated as well.

Due to the overdrive voltage curve, the SGM820xQ is less sensitive to short positive or negative variations on  $V_{CC}$ .

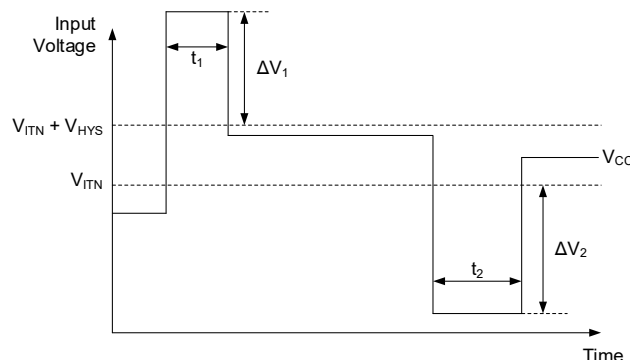


Figure 9. Overdrive Voltage

### Power Supply Recommendations

The devices operate with a wide input range from 1.6V to 6.5V. A 0.1μF ceramic capacitor is recommended between the  $V_{CC}$  and GND pin to reduce the input supply noise.

## REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

### DECEMBER 2024 – REV.A.1 to REV.A.2

	Page
Added 4.6V version .....	1, 2, 6, 10
Updated Functional Block Diagram section.....	12

### DECEMBER 2023 – REV.A to REV.A.1

	Page
Added C/D versions.....	1, 7

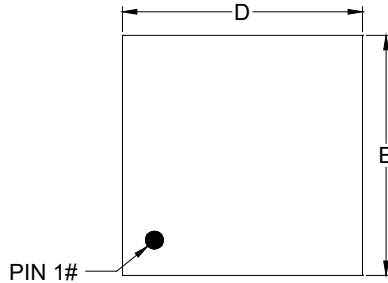
### Changes from Original (AUGUST 2023) to REV.A

	Page
Changed from product preview to production data.....	All

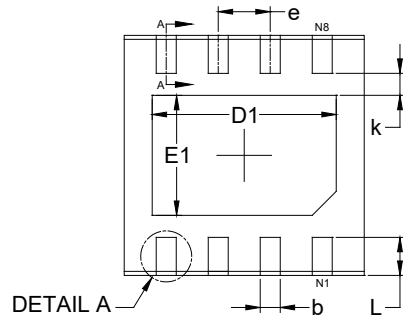


## PACKAGE OUTLINE DIMENSIONS

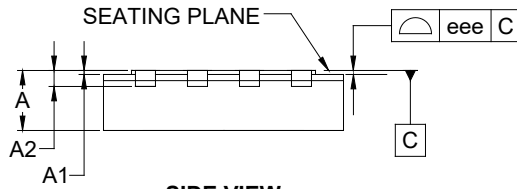
### TDFN-3×3-8GL



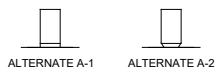
TOP VIEW



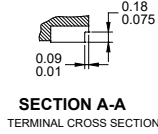
BOTTOM VIEW



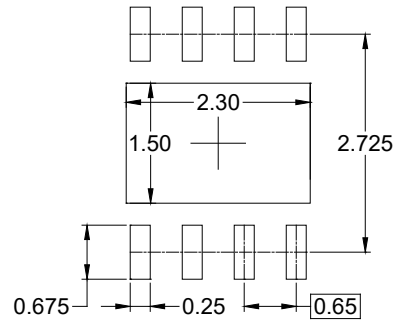
SIDE VIEW



DETAIL A  
ALTERNATE TERMINAL  
CONSTRUCTION



SECTION A-A  
TERMINAL CROSS SECTION



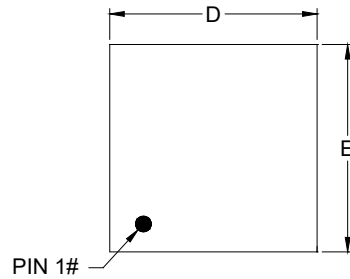
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	0.700	-	0.800
A1	0.000	-	0.050
A2	0.203 REF		
b	0.200	-	0.300
D	2.900	-	3.100
E	2.900	-	3.100
D1	2.200	-	2.400
E1	1.400	-	1.600
e	0.650 BSC		
L	0.375	-	0.575
k	0.275 REF		
eee	0.080		

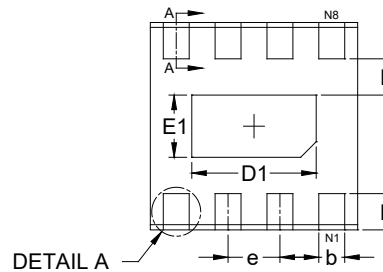
NOTE: This drawing is subject to change without notice.

## PACKAGE OUTLINE DIMENSIONS

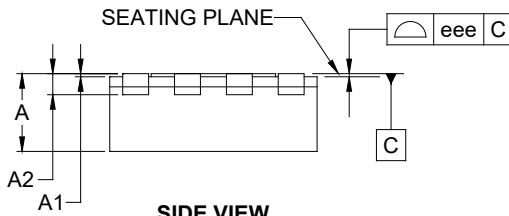
### TDFN-2x2-8DL



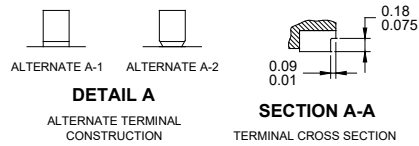
TOP VIEW



BOTTOM VIEW



SIDE VIEW

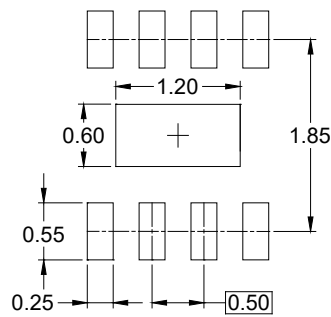


DETAIL A

ALTERNATE TERMINAL CONSTRUCTION

SECTION A-A

TERMINAL CROSS SECTION



RECOMMENDED LAND PATTERN (Unit: mm)

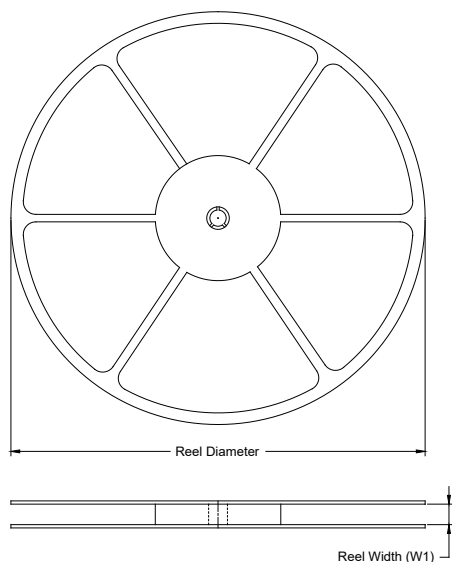
Symbol	Dimensions In Millimeters		
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A	0.700	-	0.800
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b	0.200	-	0.300
D	1.900	-	2.100
E	1.900	-	2.100
D1	1.100	-	1.300
E1	0.500	-	0.700
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L	0.250	-	0.450
k	0.350 REF		
eee	0.080		

NOTE: This drawing is subject to change without notice.

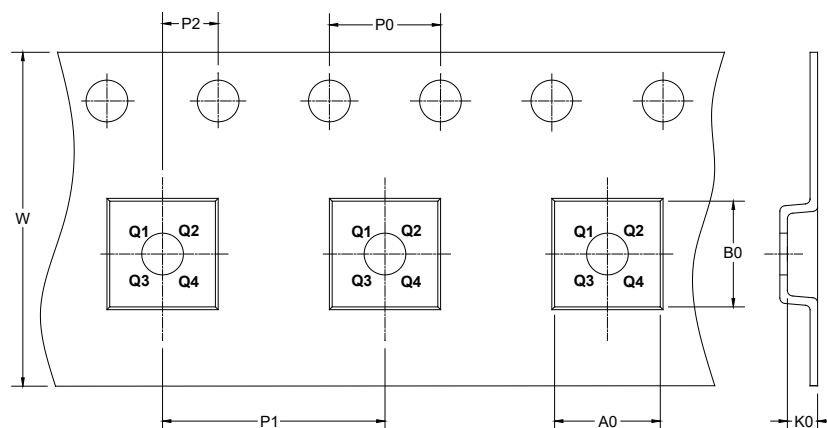
## PACKAGE INFORMATION

### TAPE AND REEL INFORMATION

#### REEL DIMENSIONS



#### TAPE DIMENSIONS



➔ DIRECTION OF FEED

NOTE: The picture is only for reference. Please make the object as the standard.

#### KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
TDFN-3×3-8GL	13"	12.4	3.35	3.35	1.13	4.0	8.0	2.0	12.0	Q2
TDFN-2×2-8DL	7"	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q2

DD0001

## PACKAGE INFORMATION

### CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

### KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7" (Option)	368	227	224	8
7"	442	410	224	18
13"	386	280	370	5

DD00002