SGM2543B
2.8V to 22V Priority Power MUX with Seamless Switchover

GENERAL DESCRIPTION

The SGM2543B is a power multiplexer which enables seamless switchover between two power supplies with wide operating range. The device can provide 4.5A continuous current and integrate a full suite protection functions including current limit, high precision over-voltage protection, inrush current control, input settling time, reverse current protection and thermal shutdown, making the device well suited for power MUX applications.

The manual and automatic switchover modes are flexible to use in different application scenarios. The device built in 60μs (TYP) switchover time and supports 15μs (TYP) fastest switchover with CP2 logic high which minimize voltage drop during switchover. A channel state indication pin ST can indicate input power supply.

The SGM2543B is available in a Green TQFN-2×2.5-12L package.

APPLICATIONS

Input Source Selection
Tracking and Telematics
Backup and Standby Power
Multiple Battery Management
EPOS and Barcode Scanners
Building Automation and Surveillance

FEATURES

- **Wide Operating Range: 2.8V to 22V**
  - **Absolute Maximum Input Voltage of 24V**
- **Low On-Resistance: 55mΩ (TYP)**
- **Fastest Switchover (t_{FSW}): 15μs (TYP)**
- **Current Limit (ILIM): 1A to 5A**
- **Programmable Over-Voltage Supervisor (OVx): Accuracy < ±5%**
- **Programmable Priority Supervisor (PR1, CP2): Accuracy < ±5%**
- **Programmable Input Settling Time and Output Soft-Start Time (SS)**
- **Channel Status Indication (ST)**
- **Low I_Q:**
  - **260μA (TYP) from Enabled Input**
  - **6μA (TYP) from Disabled Input**
- **Thermal Shutdown**

TYPICAL APPLICATION

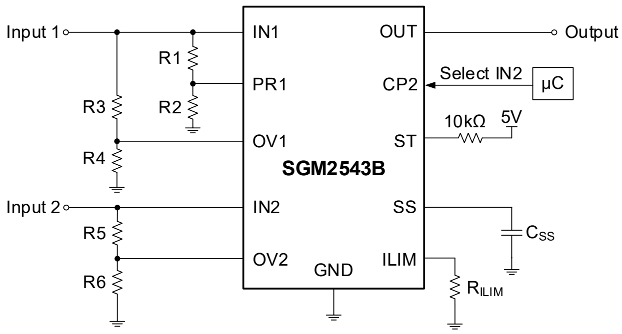


Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2543B	TQFN-2×2.5-12L	-40℃ to +125℃	SGM2543BXTVK12G/TR	10Z XXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXX = Date Code, Trace Code and Vendor Code.

Y Y Y — Serial Number
X X X X
Vendor Code
Trace Code
Date Code - Year

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.

ABSOLUTE MAXIMUM RATINGS

Power Pin Voltage, V_{IN1}, V_{IN2}, V_{OUT} .... -0.3V to 24V
Over-Voltage Pin Voltage, V_{OV1}, V_{OV2} .... -0.3V to 6V
Control Pin Voltage,
V_{PR1}, V_{CP2} .... -0.3V to 6V
V_{ST} .... -0.3V to 6V
Output Current, I_{OUT} .... Internally Limited
Package Thermal Resistance
TQFN-2×2.5-12L, θ_{JA} .... 64℃/W
TQFN-2×2.5-12L, θ_{JB} .... 6.2℃/W
TQFN-2×2.5-12L, θ_{JC} .... 51.2℃/W
Junction Temperature ....+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s) ....+260℃
ESD Susceptibility (1) (2)
HBM ....±4000V
CDM ....±1000V

NOTES:

1. For human body model (HBM), all pins comply with ANSI/ESDA/JEDEC JS-001 specifications.
2. For charged device model (CDM), all pins comply with ANSI/ESDA/JEDEC JS-002 specifications.

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.

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range, V_{IN1}, V_{IN2} .... 2.8V to 22V
Output Voltage Range, V_{OUT} .... 0V to 22V
Over-Voltage Pin Voltage, V_{OV1}, V_{OV2} .... 0V to 5.5V
Control Pin Voltage,
V_{PR1}, V_{CP2} .... 0V to 5.5V
V_{ST} .... 0V to 5.5V
ST Pin Pull-Up Resistance, R_{ST} ....6kΩ to 20kΩ
Current Limit Resistance, R_{ILIM} ....18kΩ to 100kΩ
Continuous Input Current, I_{IN1}, I_{IN2} 4.5A
Operating Junction Temperature Range ..... -40℃ to +125℃

ESD SENSITIVITY CAUTION

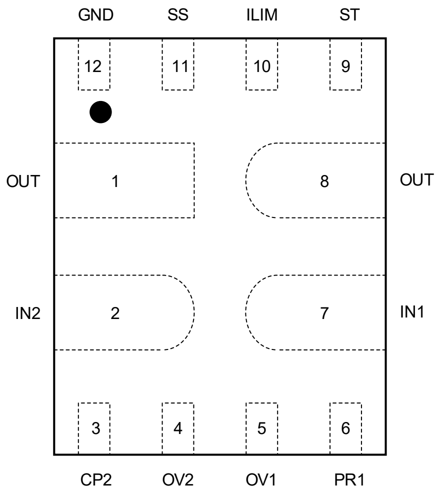
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

PIN CONFIGURATION

(TOP VIEW)



TQFN-2×2.5-12L

PIN DESCRIPTION

PIN	NAME	TYPE	FUNCTION
1, 8	OUT	O	Output of the Device.
2	IN2	I	Input Supply Voltage 2. The rise time should be higher than 20μs when IN1 powered on.
3	CP2	I	IN2 Priority Pin. Active-high to enable fastest switchover time. This pin should be connected to GND if not used.
4	OV2	I	IN2 Over-Voltage Protection Pin. This pin should be connected to GND if not used.
5	OV1	I	IN1 Over-Voltage Protection Pin. This pin should be connected to GND if not used.
6	PR1	I	IN1 Priority Pin. This pin should be connected to GND if not used.
7	IN1	I	Input Supply Voltage 1. The rise time should be higher than 20μs when IN2 powered on.
9	ST	O	Output Indicating Pin. This pin should be connected to GND if not used.
10	ILIM	O	Current Limit Programming Pin. A resistor between this pin and GND sets the overload and short-circuit current limit levels.
11	SS	I	Soft-Start Pin. The capacitor between SS and GND pins will set the slew rate and setting time according to the application requirements.
12	GND	G	Ground.

NOTE: I = input, O = output, G = ground.

ELECTRICAL CHARACTERISTICS

(V_{INx} = 2.8V to 22V, T_J = -40℃ to +125℃, typical values are at V_{INx} = 12V, T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Source (IN1, IN2)						
Quiescent Current (1)	I_{Q_INx}	V_{INx} > V_{INy}, OUT = open		260	380	μA
Standby Current (1)	I_{STBY_INx}	V_{INx} < V_{INy}, OUT = open		6	20	μA
Leakage Current (INx to OUT)	I_{LK_INx}	$\lvert V_{INx} - V_{OUT}\rvert \le$ 22V, T_J = +25℃	-1		1	μA
		$\lvert V_{INx} - V_{OUT}\rvert \le$ 22V, T_J = -40℃ to +85℃	-2		2	
		$\lvert V_{INx} - V_{OUT}\rvert \le$ 22V, T_J = -40℃ to +125℃	-4		4	
Under-Voltage Lockout	V_{UV_INx}	V_{INx} rising	2.5	2.66	2.8	V
		V_{INx} falling	2.4	2.55	2.7	
Output Switchover (OUT)						
Switchover Time	t_{SW}	V_{OUT} < V_{INx}, V_{CP2} < V_{REF_F}		60		μs
Fast Switchover Time	t_{FSW}	V_{OUT} < V_{INx}, V_{CP2} ≥ V_{REF_R}		15		μs
Input Voltage Comparator (V_{IN2} Referenced to V_{IN1})	V_{COMP}	V_{IN1} ≥ V_{IN2}	60	334	600	mV
		V_{IN1} > V_{IN2}, falling Hysteresis	120	458	800	
On-Resistance (INx to OUT)						
On-Resistance	R_{DSON}	I_{OUT} = -200mA, V_{INx} ≥ 5V, T_J = +25℃		55	72	mΩ
		I_{OUT} = -200mA, V_{INx} ≥ 5V, T_J = -40℃ to +85℃			88	
		I_{OUT} = -200mA, V_{INx} ≥ 5V, T_J = -40℃ to +125℃			100	
Current Limit (ILIM)						
Output Current Limit	I_{LIM}	R_{ILIM} = 18.7kΩ, V_{IN} - V_{OUT} = 1V (2)	4.4	5	6	A
		R_{ILIM} = 22.1kΩ, V_{IN} - V_{OUT} = 1V (2)	3.9	4.5	5.4	
		R_{ILIM} = 29.8kΩ, V_{IN} - V_{OUT} = 1V	3.1	3.5	4.15	
		R_{ILIM} = 44.2kΩ, V_{IN} - V_{OUT} = 1V	2.1	2.6	3.1	
		R_{ILIM} = 80kΩ, V_{IN} - V_{OUT} = 1V	1.1	1.6	2.1	
		R_{ILIM} < 1kΩ, V_{IN} - V_{OUT} = 1V	1.5	2.5	3.5	
Current Limit Response Time	t_{LIM}	R_{ILIM} = 18.7kΩ, I_{OUT} ≥ 1.2 × I_{LIM} to I_{OUT} ≤ I_{LIM}		200		μs
Circuit Breaker Threshold	I_{nFAULT}	ILIM pin open		0.5		A
		ILIM pin shorted to GND		2.5		
Control Pins (PR1, CP2, OV1, OV2)						
Internal Voltage Reference	V_{REF_R}	V_{PR1}, V_{CP2}, V_{OV1}, V_{OV2} rising	1.01	1.06	1.10	V
	V_{REF_F}	V_{PR1}, V_{CP2}, V_{OV1}, V_{OV2} falling	0.99	1.04	1.09	V
Comparator Offset Voltage	V_{OFST}	V_{PR1} > V_{REF_R}, V_{CP2} > V_{REF_R}	5	22	40	mV
Leakage Current	I_{LK_x}	V_{PR1}, V_{CP2}, V_{OV1}, V_{OV2} = 0V to 5.5V	-1		1	μA
Status Indication Pin (ST)						
Leakage Current	I_{LK_ST}	V_{ST} = 0V to 5.5V	-1		1	μA
Status Delay Time	t_{ST}	L to H		2.7		μs

ELECTRICAL CHARACTERISTICS (continued)

(V_{INx} = 2.8V to 22V, T_J = -40℃ to +125℃, typical values are at V_{INx} = 12V, T_J = +25℃, unless otherwise noted.)

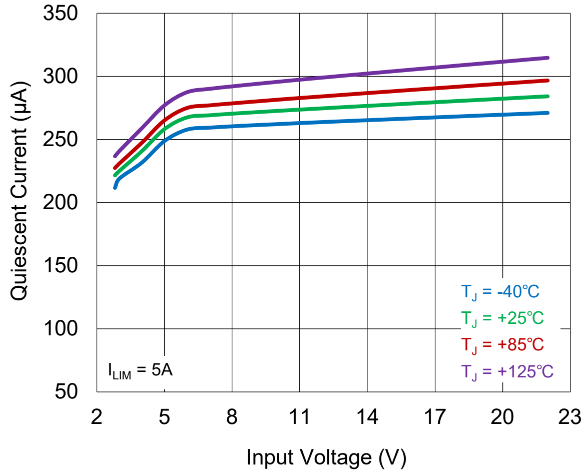
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Fast Reverse Current Blocking (RCB)						
Fast Reverse Current Detection Threshold	I_{RCB}	V_{OUT} > V_{INx}	0.2	1	2	A
RCB Release Voltage	V_{RCB}	V_{OUT} > V_{INx}	0	30	60	mV
Reverse Current Blocking Response Time	t_{RCB}	(V_{OUT} to V_{IN}) 200mA overdrive above I_{RCB} to power MOS off		10		μs
Reverse Current Release Response Time	t_{RCB_RELEAE}	(V_{OUT} to V_{IN}) 10mV overdrive below V_{RCB} to power MOS on		1		μs
Thermal Shutdown (TSD)						
Thermal Shutdown	T_{SD}	Shutdown, rising		160		℃
	T_{HYS}	Recovery, falling		10		℃
Thermal Shutdown Auto-Retry Interval	t_{TSD_RST}			60		ms

NOTES:
1. Quiescent current is drawn from the highest voltage of IN1 and IN2, and standby current is drawn from the lowest voltage of IN1 and IN2 based on V_{COMP} scheme, independent of PR1 and CP2.
2. Guaranteed by design.

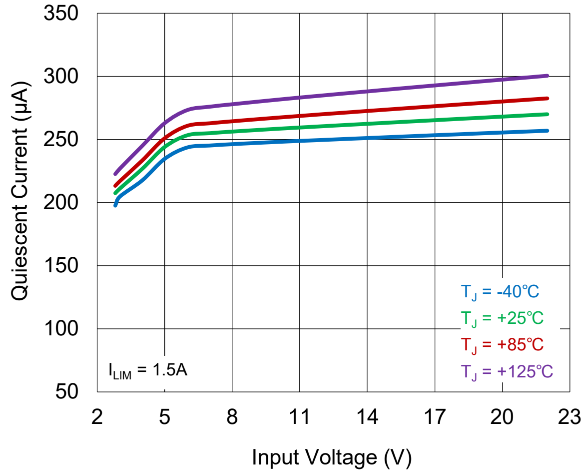
TYPICAL PERFORMANCE CHARACTERISTICS

T_J = +25℃, unless otherwise noted.

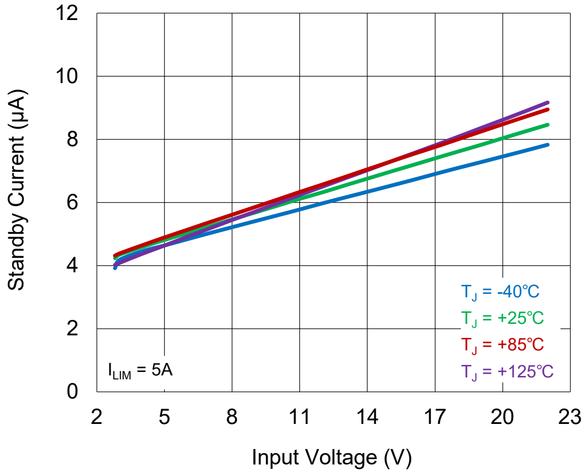
Quiescent Current vs. Input Voltage



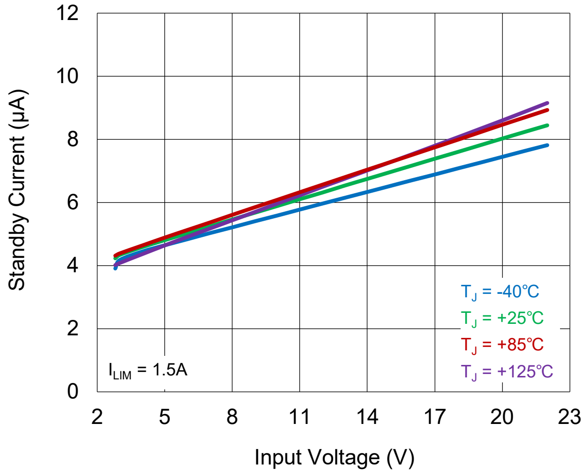
Quiescent Current vs. Input Voltage



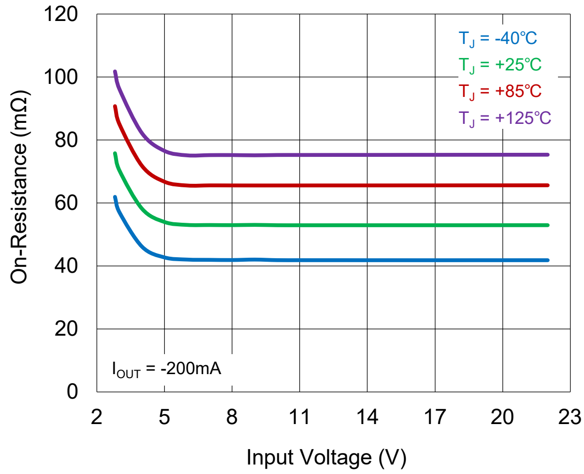
Standby Current vs. Input Voltage



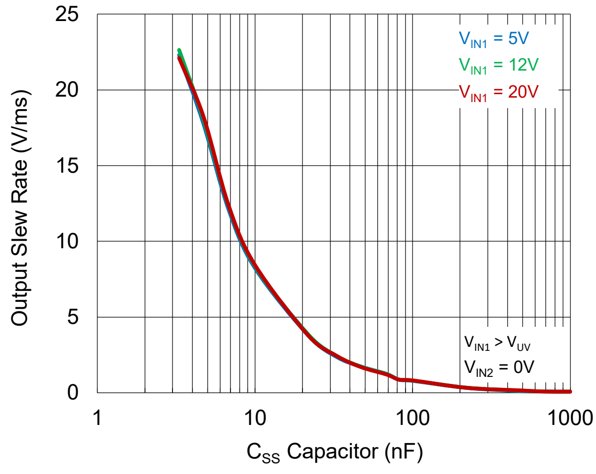
Standby Current vs. Input Voltage



On-Resistance vs. Input Voltage



Output Slew Rate vs. C_{SS} Capacitor



FUNCTIONAL BLOCK DIAGRAM

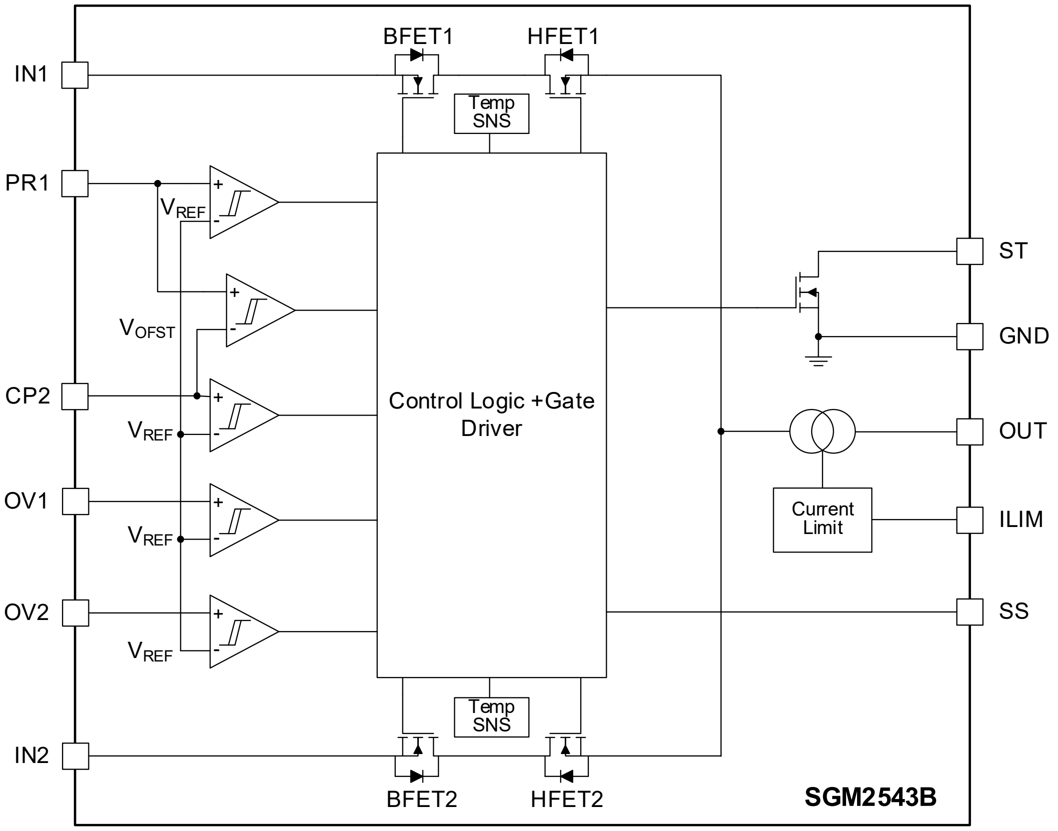


Figure 2. Block Diagram

DETAILED DESCRIPTION

Overview

The SGM2543B is a power multiplexer which enables seamless switchover between two power supplies with wide operating range. The device can provide 4.5A continuous current and integrate a full suite protection functions including current limit, high precision over-voltage protection, inrush current control, input settling time, reverse current protection and thermal shutdown, making the device well suited for power MUX applications.

The manual and automatic switchover modes are flexible to use in different application scenarios. The device has a built-in 60μs (TYP) switchover time and supports 15μs (TYP) fastest switchover with CP2 logic high which minimize voltage drop during switchover. A channel state indication pin (ST) can indicate input power supply.

Input Settling Time and Output Soft-Start Control (SS)

When the first input voltage is at V_{IN1} > UVLO, $V_{OV1} < V_{REF\_R}$ state, the input is recognized by the device as the valid operating voltage, the internal current source charges C_{SS} to about 1.1V as the setting time (t_{SET1}), then the output starts to soft-start. The C_{SS} voltage continues to increase and set output soft-start slew rate until the soft-start ends, C_{SS} is pulled down to GND and is reused until next valid voltage.

When the second input voltage is at V_{IN2} > UVLO, $V_{OV2} < V_{REF\_R}$ state, the internal current source charges C_{SS} to about 1.1V as the setting time (t_{SET2}), at this time, the device will determine the input source based on real-time status. If the second source is not selected, C_{SS} will immediately pull down to GND. If the second source is selected (e.g. $V_{IN2} > V_{IN1}$), the C_{SS} voltage continues to increase and set output soft-start slew rate until the soft-start ends, C_{SS} is pulled down to GND and is reused until next valid voltage.

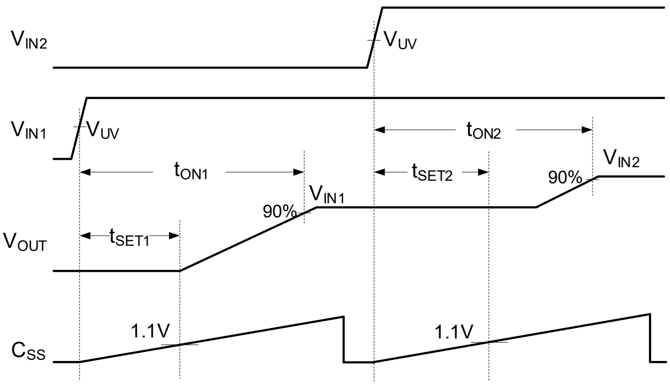


Figure 3. Settling and Soft-Start Timing

If V_{IN2} is valid during t_{ON1}, the device will immediately determine the input source based on real-time status.

Slew Rate

Table 1 shows the slew rate of different C_{SS} capacitors and V_{IN} voltages.

Table 1. Slew Rate vs. C_{SS} Capacitor

C_{SS} Capacitor	V_{IN} = 5V	V_{IN} = 12V	V_{IN} = 20V
100nF	800V/s	810V/s	820V/s
1μF	74V/s	78V/s	78V/s
10μF	8.4V/s	8.9V/s	9.6V/s

Active Current Limit (ILIM)

The current limit protection circuit is designed to protect the upstream power supply by limiting the output current to the current limit threshold set by the R_{ILIM} from ILIM pin to GND. For a given over-current threshold, the value of R_{ILIM} can be calculated below.

$$I_{LIM}(A) = \frac{51}{R_{ILIM}^{0.789}(k\Omega)} \quad (1)$$

DETAILED DESCRIPTION (continued)

During the active current limit, there is more power dissipation on the device because the output voltage drops. If the internal temperature (T_J) of the device exceeds the thermal shutdown threshold (T_{SD}), the FETs will be turned off, and the device will restart automatically after a certain time interval.

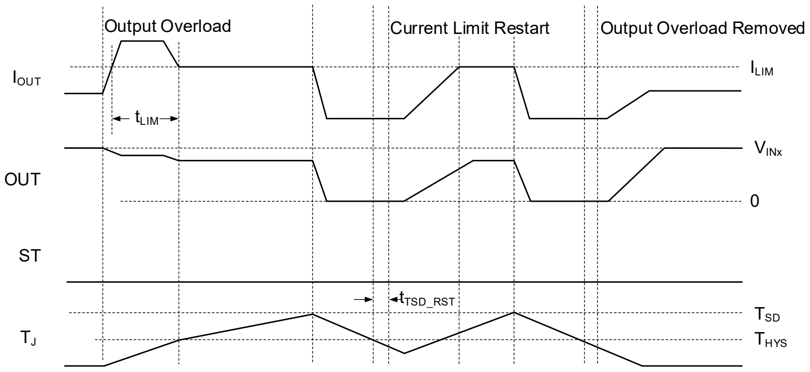


Figure 4. Current Limit Behavior

Short-Circuit Protection

When a serious over-current event similar to a short-circuit event occurs, the SGM2543B triggers a fast-trip response to prevent the system from being damaged by excessive current flowing through the device. A fast-trip comparator with scalable threshold (I_{FT} = 2 × I_{LIM}) is adopted inside the device, which allows users to program the fast-trip threshold in low current system. The FET will be completely turned off about 500ns if the current exceeds I_{FT}. The device will turn off the FET with t_{TSD_RST} and then turn it on again in a current limit mode. If the fault persists, the device continues to operate in the current limit mode, causing the internal temperature of the device to rise until the thermal shutdown.

Thermal Protection (T_{SD})

The SGM2543B integrates two types of over-temperature protection: absolute over-temperature protection and relative over-temperature protection. Absolute over-temperature protection monitors the temperature of the internal FETs. Once the temperature exceeds the T_{SD}, the device shuts down immediately and it remains in the shutdown state until the internal temperature drops by T_{HYS}. After that, it will retry to turn on automatically after a t_{TSD_RST} delay time. Relative over-temperature protection also monitors the temperature of logical circuit, if the temperature difference between FETs and logic circuit exceeds 60℃, the device will immediately turn off. The device will restart when the temperature difference drops by 20℃ and t_{TSD_RST} delay time.

Over-Voltage Protection (OVx)

The SGM2543B can implement user-programmable input over-voltage threshold through an external resistor divider. When the power supply voltage exceeds a certain level, the device turns off the supply and switches to another valid input. The resistance divider feeds the divided voltage of the power supply to the OVx pin. When the voltage at the OVx pin exceeds the threshold (V_{REF_R}), the channel is disabled. When the OVx pin voltage falls below the threshold (V_{REF_F}), the channel retries to turn on.

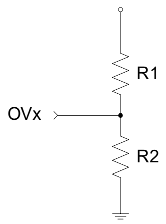


Figure 5. OVP Resistor Configuration

DETAILED DESCRIPTION (continued)

True Reverse Current Blocking (RCB)

The device integrates true reverse current blocking protection. When the output voltage exceeds the input voltage by V_{IRCB}, the channel will turn off to avoid the reverse current I_{RCB} from the output to input within t_{RCB}. When V_{OUT} - V_{IN} forward drops to the V_{RCB}, the channel will respond with t_{FSW} delay and turns on with current limit soft-start to avoid voltage dip.

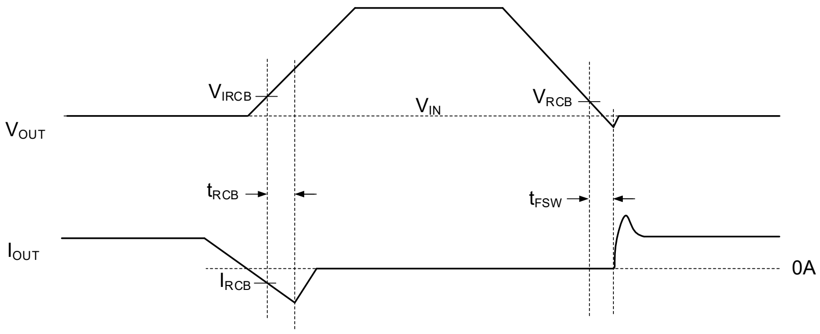


Figure 6. Reverse Current Blocking Behavior

Input Voltage Comparator (VCOMP)

If both inputs are valid voltage and PR1 = CP2 = low, the input source will depend on the magnitude of the input voltages, see Figure 7 below. IN1 has higher priority if $V_{IN1} > V_{IN2} + V_{COMP}$ + Hysteresis, and if IN1 drops to $V_{IN1} < V_{IN2} + V_{COMP}$, then IN2 takes higher priority.

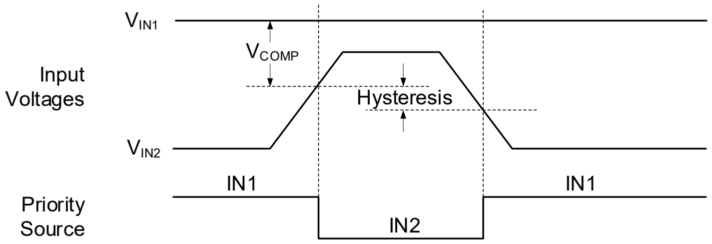


Figure 7. VCOMP Priority Source Selection

VREF Comparator (VREF)

PR1 prioritizes supply 1 when PR1 = high, CP2 = low and CP2 prioritizes supply 2 when CP2 = high, PR1 = low. If both of them are higher than V_{REF_R}, IN1 has higher priority if $V_{PR1} > V_{CP2} + V_{OFST}$, and if PR1 drops to $V_{PR1} < V_{CP2}$, then IN2 takes higher priority, see Figure 8 below.

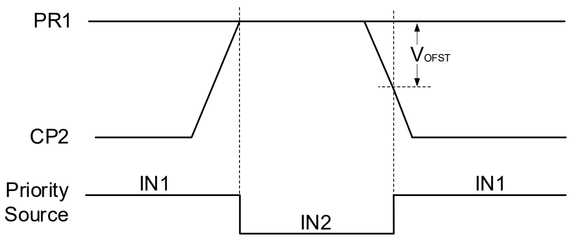


Figure 8. VREF Priority Source Selection

DETAILED DESCRIPTION (continued)

Output Voltage Dip and Switchover Control

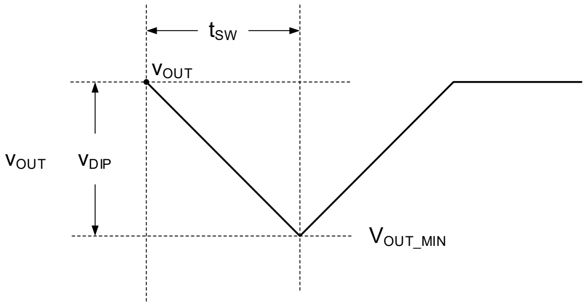
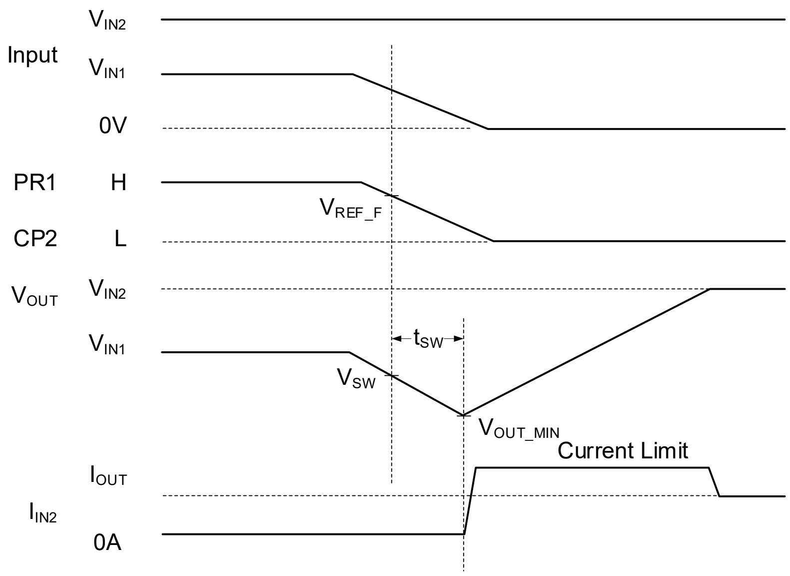


Figure 9. Minimum Output Voltage during Switchover

If the output switches from lower to higher voltage, the device utilizes fast switchover time (t_{FSW}) when CP2 = high or normal switchover time (t_{SW}) when CP2 = low. The output voltage drop (V_{DIP}) depends on load current (I_{OUT}) and load capacitance (C_{OUT}):

$$V_{DIP} = t_{SW} \times \left(\frac{I_{OUT}}{C_{OUT}}\right) \quad (2)$$

Channel 1 has higher priority with PR1 = high, CP2 = low. As the voltage of channel 1 decreases, $V_{PR1} < V_{REF\_F}$. Channel 1 turns off immediately. Output switches over to channel 2 respond with t_{SW} delay and turns on with current limit soft-start.



$V_{OUT\_MIN} = V_{SW} - V_{DIP}$

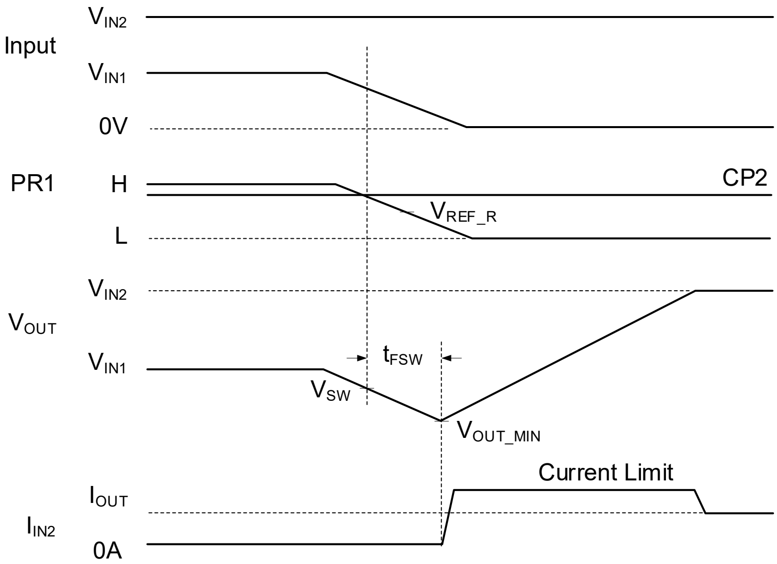
$V_{OUT\_MIN} = V_{SW} - (t_{SW} \times I_{OUT}/C_{OUT})$

$V_{OUT\_MIN} = 5V - (60\mu s \times 1A/100\mu F) = 4.4V$

Figure 10. Switchover from Lower to Higher Voltage

DETAILED DESCRIPTION (continued)

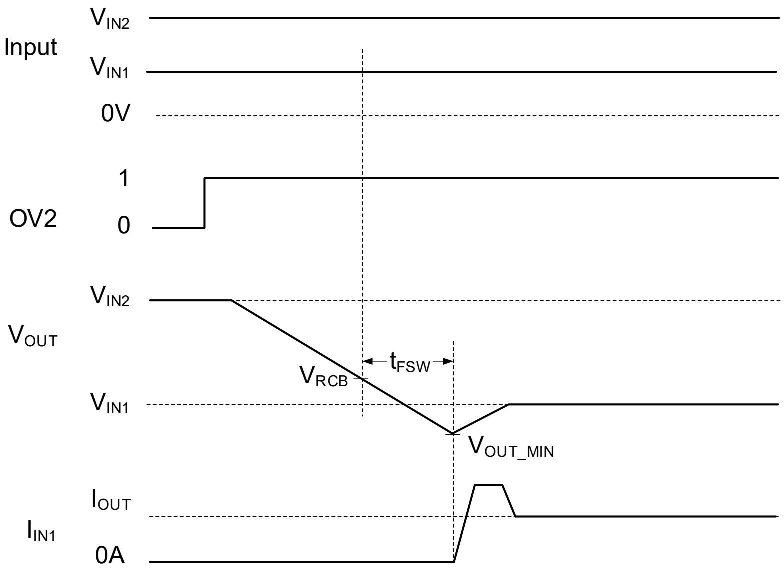
If channel 1 has higher priority with $V_{PR1} > V_{CP2} > V_{REF\_R}$. As the voltage of channel 1 decreases, $V_{CP2} > V_{PR1} > V_{REF\_R}$. Channel 1 turns off immediately. Output switches over to channel 2 respond with t_{FSW} delay and turns on with current limit soft-start.



$$V_{OUT\_MIN} = V_{SW} - V_{DIP}$$
$$V_{OUT\_MIN} = V_{SW} - (t_{FSW} \times I_{OUT}/C_{OUT})$$
$$V_{OUT\_MIN} = 5V - (15\mu s \times 1A/100\mu F) = 4.85V$$

Figure 11. Fast Switchover from Lower to Higher Voltage

When the output switches from higher to lower voltage, higher voltage turns off immediately and lower voltage turns on until V_{OUT} drops to V_{RCB}, the channel will respond with t_{FSW} delay and turns on with current limit soft-start regardless of the status of CP2.



$$V_{OUT\_MIN} = V_{IN1} + V_{RCB} - (t_{FSW} \times I_{OUT}/C_{OUT})$$
$$V_{OUT\_MIN} = 5V + 32mV - (15\mu s \times 1A/100\mu F) = 4.88V$$

Figure 12. Fast Switchover from Higher to Lower Voltage

DETAILED DESCRIPTION (continued)

SGM2543B Device Functional Modes

Table 2 shows the SGM2543B priority behavior.

Table 2. SGM2543B Output Source Selection Table

Device Inputs						Device Outputs		Mode of Operation
$V_{IN1} \le V_{UV}$ or $V_{OV1} \ge V_{REF}$	$V_{IN2} \le V_{UV}$ or $V_{OV2} \ge V_{REF}$	$V_{CP2} \ge V_{REF}$	$V_{PR1} \ge V_{REF}$	VCOMP	VREF	OUT	ST	MODE
0	0	0	0	$V_{IN2} < V_{IN1}$	X	IN1	H	VCOMP
0	0	0	0	$V_{IN2} \ge V_{IN1}$	X	IN2	L	VCOMP
0	0	0	1	X	X	IN1	H	VREF
0	0	1	0	X	X	IN2	L	VREF
0	0	1	1	X	$V_{PR1} > V_{CP2}$	IN1	H	VREF
0	0	1	1	X	$V_{PR1} \le V_{CP2}$	IN2	L	VREF
0	1	X	X	X	X	IN1	H	UV/OV
1	0	X	X	X	X	IN2	L	UV/OV
1	1	X	X	X	X	Hi-Z	H	Invalid Inputs

A summary of the priority of the SGM2543B:

If only one input is valid, then the input will power the output.
If both inputs are valid, PR1 and CP2 are low, then the higher voltage of input takes priority.
If both inputs are valid, PR1 is high and CP2 is low, then the IN1 takes priority.
If both inputs are valid, PR1 is low and CP2 is high, then the IN2 takes priority.
If both inputs are valid, PR1 and CP2 are high, then the higher voltage of PR1 or CP2 takes priority.
Fast switchover time is enabled by pulling CP2 high.
ST is pulled high when the output is Hi-Z or IN1 and is pulled low when IN2 is powering the output. ST indication is not related to operating conditions, such as OV, OC, SC, OT, RCB.

APPLICATION INFORMATION

Table 3. SGM2543B Application Summary Table

MODE	DESCRIPTION
Manual Switchover (VREF)	Manually determine input priority through external controller.
Automatic Switchover with Priority (VREF)	IN1 power on when IN1 valid, and switches to IN2 when IN1 drops.
Highest Voltage Operation (VCOMP)	Higher voltage is selected as input source.

SGM2543B is a highly flexible backup device well suitable for different application scenarios. Two important factors affect the design process:

- OUT voltage drops during switchover
- Switchover modes

The output voltage drop (V_{DIP}) depends on switchover time, load current and load capacitance, in which fast switchover time can be determined by pulling CP2 high. Switchover modes include manual switchover and automatic switchover. Three typical application circuits are shown below.

Manual Switchover Schematic

Figure 13 shows the application schematic for manual switchover on the SGM2543B.

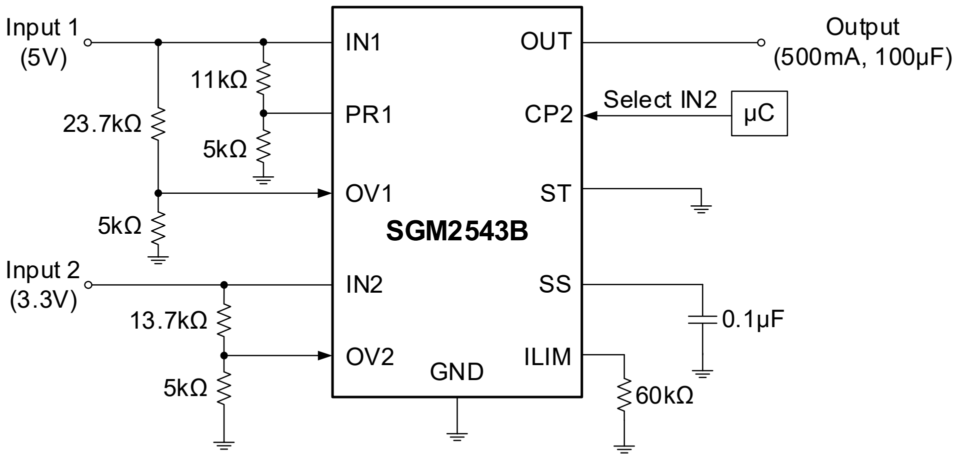


Figure 13. SGM2543B Manual Switchover

Design Requirements

In power architecture with MCU or microcontroller, the controller can manually switch input sources through GPIO according to real-time load conditions. Generally, GPIO signal is connected to PR1 or CP2 to forcibly switch input sources regardless of their voltage levels. Table 4 summarizes the design requirements.

Table 4. Manual Switchover Design Requirements

DESIGN PARAMETER	DETAILS
IN1 Voltage, V_{IN1}	5V
IN2 Voltage, V_{IN2}	3.3V
Load Current, I_{OUT}	500mA
Load Capacitance, C_L	100μF
Maximum Inrush Current, I_{INRUSH}	100mA
Current Limit	2A
Fast Switchover Time, t_{FSW}	15μs
Mode of Operation	VREF
External MCU Signal, V_{MCU}	3.3V
Over-Voltage Protection, V_{OV1}, V_{OV2}	OV1: 6.1V, OV2: 4V

APPLICATION INFORMATION (continued)

Detailed Design Description

The SGM2543B device can be manually switched between two input sources through an external control signal. In this design requirement, the external MCU signal will determine the priority of the input sources. Based on the above design parameters, when IN2 (3.3V) switches to IN1 (5V), the output voltage drop is determined by the switchover time.

Manual switchover is based on VREF comparator scheme. The MCU control signal will be connected to PR1 or CP2 for comparison with the internal reference voltage to determine priority. In this application, the MCU control signal is connected to CP2 and IN1 is connected to PR1 through an external resistor divider. The priority depends on the voltage levels of PR1 and CP2. OV1 and OV2 are respectively connected to IN1 and IN2 through resistor dividers to provide over-voltage protection. The ST pin is an open-drain output that can be pulled high with a resistor to provide input source status. ST is pulled high when the output is Hi-Z or IN1 and is pulled low when IN2 is powering the output. If this function is not required, the ST pin can be connected to GND.

According to the design parameters, pulling CP2 high can enable fast switchover to minimize voltage drop on VOUT. CP2 needs to remain higher than V_{REF_R}, 1.06V (TYP). The PR1 voltage on the IN1 resistor divider is also higher than V_{REF_R}. Compare the voltage on pins PR1 and CP2 to determine input source. If the voltage on PR1 is higher than CP2, IN1 takes the priority. If the voltage on PR1 is lower than CP2, IN2 powers the output.

Design Procedure

Selecting PR1 and CP2 Resistors

The 3.3V external control signal can be directly connected to CP2. The voltage on PR1 needs to be higher than V_{REF_R} and lower than 3.3V. This allows the controller to control the voltage on CP2 to complete power source switchover.

In addition, when the control signal is low, i.e. CP2 = low, the device can automatically switchover when the IN1 voltage is lower than the IN2 voltage by configuring the voltage divider resistor value: When IN1 drops to 3.3V, the corresponding PR1 voltage should be lower than V_{REF_F}. PR1 and CP2 are both low and higher voltage takes priority in VCOMP switchover mode. The bottom resistor is chosen to be 5kΩ due to universality and less leakage current. Based on this, the top resistor is selected to be 11kΩ.

$$V_{REF\_F} = V_{IN1} \times \frac{5k\Omega}{5k\Omega + 11k\Omega} \tag{3}$$

$$V_{IN1} = 3.33V$$

When IN1 drops to 3.33V, switchover mode changes into VCOMP scheme, the input source will automatically switch to IN2.

Selecting OVx Resistors

Both IN1 and IN2 have independent input over-voltage protection. By using a resistor divider, the voltage of OV1 and OV2 can be adjusted to obtain an independent over-voltage protection threshold. When the inputs are powered on, the OV1 and OV2 voltages will be monitored. If the pin voltage exceeds V_{REF_R} (1.06V), the corresponding channel will be immediately turned off. Based on the design parameters, the resistance values of IN1 and IN2 are 23.7kΩ, 5kΩ, 13.7kΩ, 5kΩ, the respective over-voltage protection thresholds are:

$$V_{IN1\_OV} = 1.06V \times \frac{5k\Omega + 23.7k\Omega}{5k\Omega} \tag{4}$$

$$V_{IN1\_OV} = 6.08V$$

$$V_{IN2\_OV} = 1.06V \times \frac{5k\Omega + 13.7k\Omega}{5k\Omega} \tag{5}$$

$$V_{IN2\_OV} = 3.96V$$

APPLICATION INFORMATION (continued)

Selecting Soft-Start Capacitor and Current Limit Resistors

The R_{ILIM} values can be calculated using Equation 1. According to the design parameters, current limit is 2A. R_{ILIM} is 60kΩ.

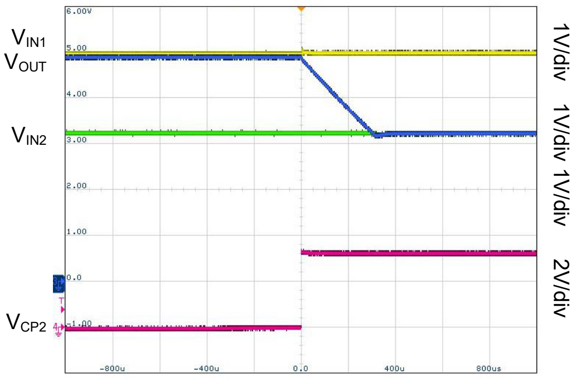
The maximum inrush current is limited to 100mA. The maximum soft-start slew rate can be calculated through Equation 6:

$$SR_{ON} = \frac{I_{INRUSH}}{C_L} \tag{6}$$

$$SR_{ON} = \frac{100mA}{100\mu F} = 1000V/s$$

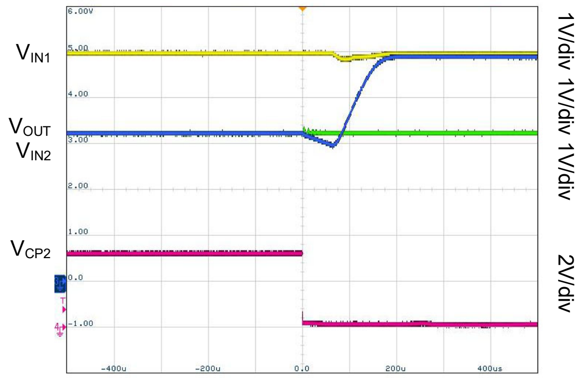
According to Equation 6, the maximum slew rate is not allowed exceed 1000V/s. Referring to Table 1, 5V input voltage with 100nF C_{SS} capacitor, the typical slew rate is 800V/s, resulting in 80mA inrush current. Therefore, a 100nF capacitor is selected to limit inrush current.

Switchover from IN1 to IN2



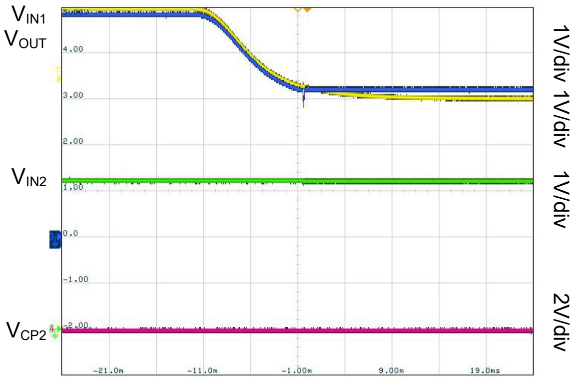
Time (200μs/div)

Switchover from IN2 to IN1



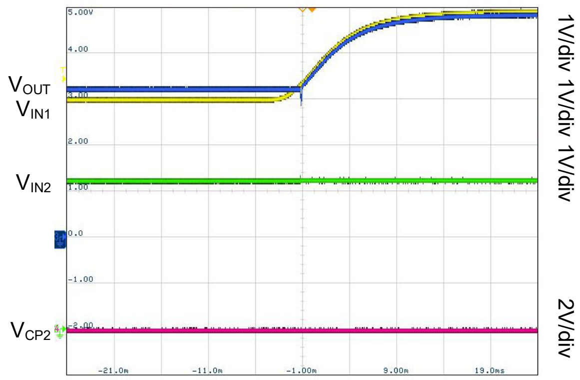
Time (100μs/div)

Switchover from IN1 to IN2 when IN1 drops



Time (5ms/div)

Switchover from IN2 to IN1 when IN1 recovers



Time (5ms/div)

APPLICATION INFORMATION (continued)

Automatic Switchover with Priority (VREF)

In some special application scenarios, interruption of load power supply is not allowed. If the main input source fails, the system needs to automatically switchover to the auxiliary source without interrupting normal operation. The example shows a 12V main power supply and a 5V auxiliary power supply, such as a lithium battery. IN1 powers on when IN1 is valid and switches to IN2 when IN1 fails.

Application Schematic

The automatic switchover of SGM2543B between 12V and 5V power supplies shows as below.

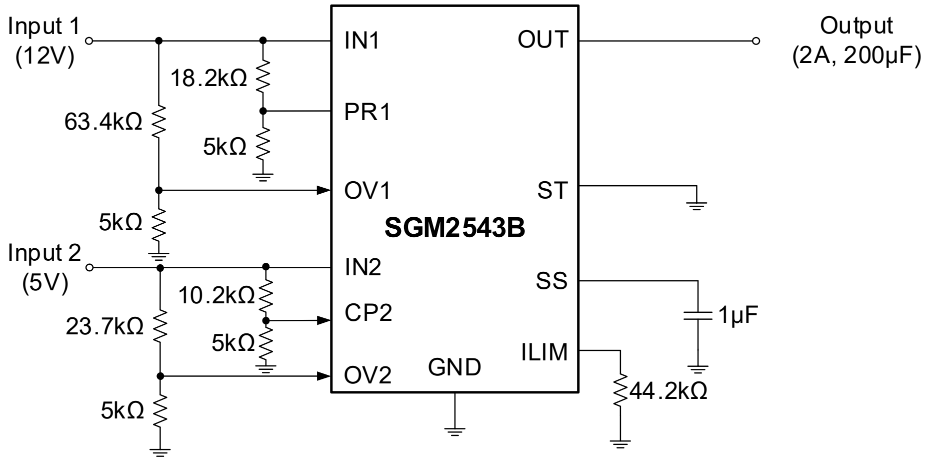


Figure 14. Automatic Switchover between 12V and 5V

Design Requirements

Table 5. Automatic Switchover Design Requirements

DESIGN PARAMETER	DETAILS
IN1 Voltage, V_{IN1}	12V
IN2 Voltage, V_{IN2}	5V
Load Current, I_{OUT}	2A
Load Capacitance, C_L	200μF
Maximum Inrush Current, I_{INRUSH}	100mA
Fast Switchover Time, t_{FSW}	15μs
Mode of Operation: Automatic Switchover	VCOMP

Detailed Design Description

This example shows the automatic switchover from the main power source (IN1) to the auxiliary source (IN2). In this application scenario, the auxiliary power source is a permanent backup power source such as a 5V lithium battery, and the load device is not allowed to be interrupted. When the main power supply fails, the switchover process should ensure that the voltage drop on the output is minimized to prevent downstream loads from restarting or shutdown.

To minimize the output voltage drop during the switchover process, the switchover voltage of IN1 should be higher than IN2. After switchover process, the output voltage is still higher than IN2. When IN2 is released from the reverse protection state, it will switch quickly with t_{FSW}. When the main power supply is returns, it will power on again.

Compared to the previous typical application, the priority of the input source is determined through PR1 and CP2. However, this example does not have an external controller signal. Through a resistor divider, PR1 and CP2 are connected to IN1 and IN2 respectively, to determine the switchover threshold of IN1.

APPLICATION INFORMATION (continued)

Design Procedure

Selecting PR1 and CP2 Resistors

In this application, the switching voltage of IN1 is 7.6V, if the voltage of IN1 drops to 7.6V, the device will switch from IN1 to IN2. When IN1 is 7.6V, the voltage of PR1 and CP2 is equal.

V_{CP2} voltage can be calculated in Equation 7.

$$V_{CP2} = 5V \times \frac{5k\Omega}{5k\Omega + 10.2k\Omega} = 1.64V \quad (7)$$

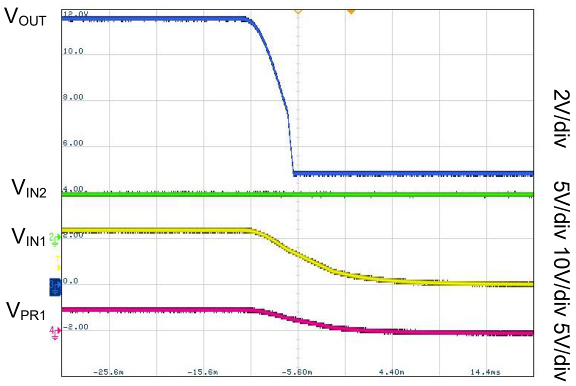
When IN1 is 7.6V, the corresponding PR1 voltage is 1.64V, 18.2kΩ and 5kΩ are selected.

$$V_{PR1\_7.6V} = 7.6V \times \frac{5k\Omega}{5k\Omega + 18.2k\Omega} = 1.64V \quad (8)$$

When IN1 is in steady state, PR1 is 2.59V and takes higher priority.

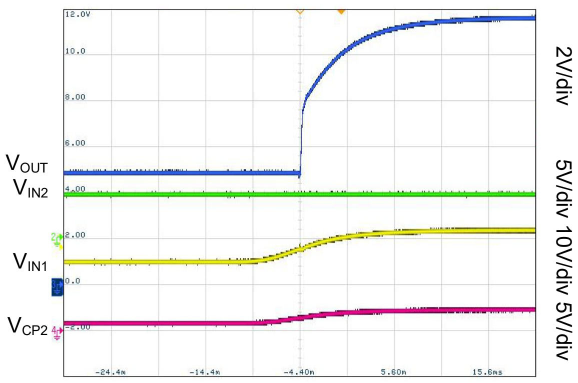
$$V_{PR1\_12V} = 12V \times \frac{5k\Omega}{5k\Omega + 18.2k\Omega} = 2.59V \quad (9)$$

Switchover from IN1 to IN2 when IN1 Drops



Time (5ms/div)

Switchover from IN2 to IN1 Recovers



Time (5ms/div)

APPLICATION INFORMATION (continued)

Highest Voltage Operation (VCOMP)

Application Schematic

Figure 15 shows the typical application of V_{COMP} operation: the highest voltage operation on the SGM2543B.

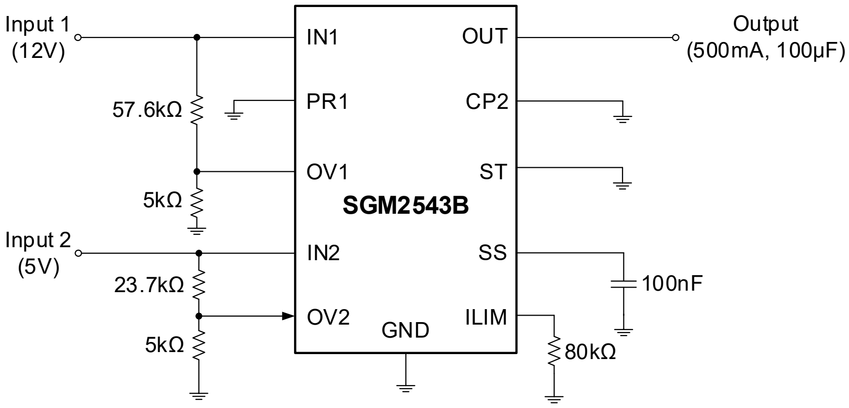


Figure 15. Highest Voltage Operation

Design Requirements

Table 6. Highest Voltage Design Requirements

DESIGN PARAMETER	DETAILS
Input Voltage, V_{IN1}, V_{IN2}	12V
Output Voltage, V_{OUT}	5V
Load Current, I_{OUT}	0.5A
Load Capacitance, C_L	100μF
Switchover Time, t_{SW}	100μs
Mode of Operation: Automatic Switchover	VCOMP

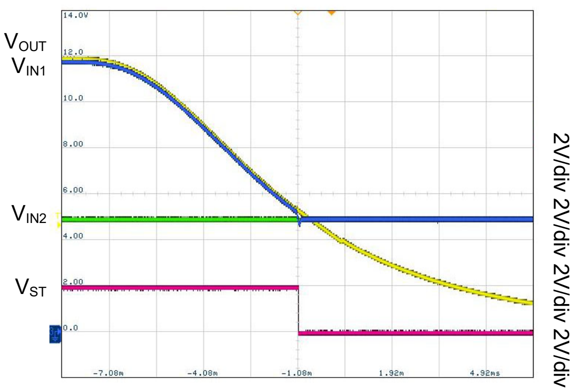
Detailed Design Description

When both inputs are valid voltage and PR1, CP2 are below V_{REF_F}. The device is in VCOMP switchover mode. In this operating mode, the device will determine priority through an internal comparator, prioritizing the highest input voltage. Referring to Figure 7, in steady-state operation, IN1 is higher than IN2, IN1 has a higher priority. If IN1 drops below V_{COMP} + V_{IN2}, IN2 will take priority. IN1 will take priority again, when V_{IN1} > V_{IN2} + V_{COMP} + Hysteresis.

Detailed Design Procedure

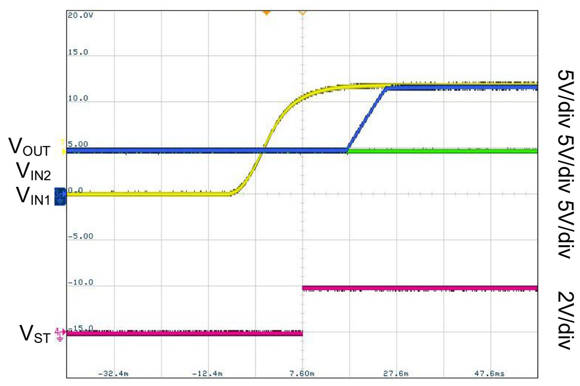
The design parameters demonstrate the application of 12V main and 5V auxiliary input. When in steady state, IN1 has priority. When the voltage of IN2 remains constant, IN1 drops to 5V + 300mV, at 5.3V, the device switches to IN2 power supply. When IN1 rises to 5V + 300mV + 390mV, at 5.69V, the device resumes IN1 power supply.

Switchover from IN1 to IN2 when IN1 Drops



Time (1.5ms/div)

Switchover from IN2 to IN1 Recovers



Time (10ms/div)

APPLICATION INFORMATION (continued)

Reverse Polarity Protection with SGM2543B

For some applications, it is necessary to prevent the risk of input reverse voltage by placing a diode between the device GND and the system GND. The minimal standoff voltage of diode must be higher than absolute voltage of the device. The logical pins should be referenced to the device GND to avoid threshold deviation due to diode voltage drop.

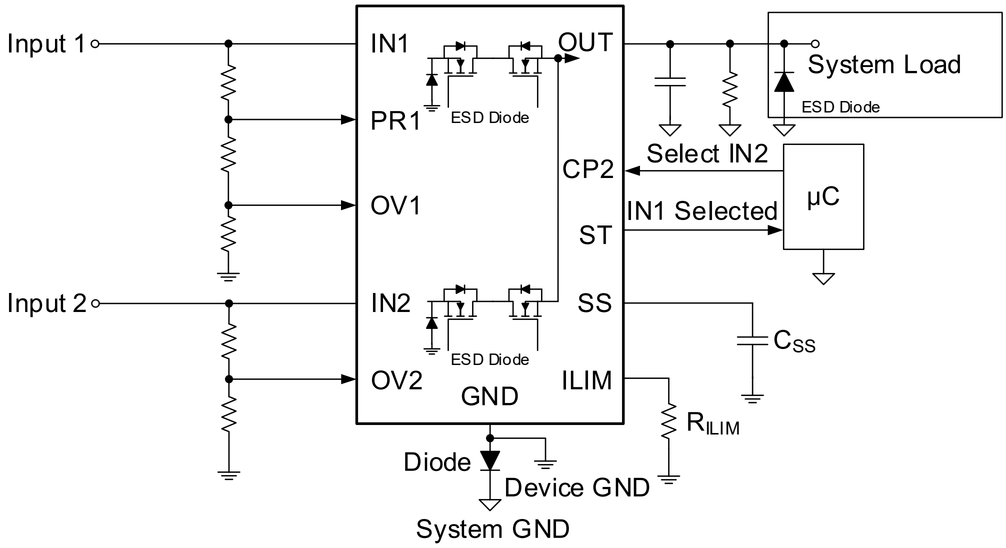


Figure 16. SGM2543B Reverse Polarity Configuration

Hot Plug with SGM2543B

Hot swappable power on is commonly used in some USB application scenarios. In hot plug events, the inductance on the long cable and the PCB routing will cause significant voltage spikes at the input pins. If these voltage spikes exceed the absolute rated voltage, the device may be damaged.

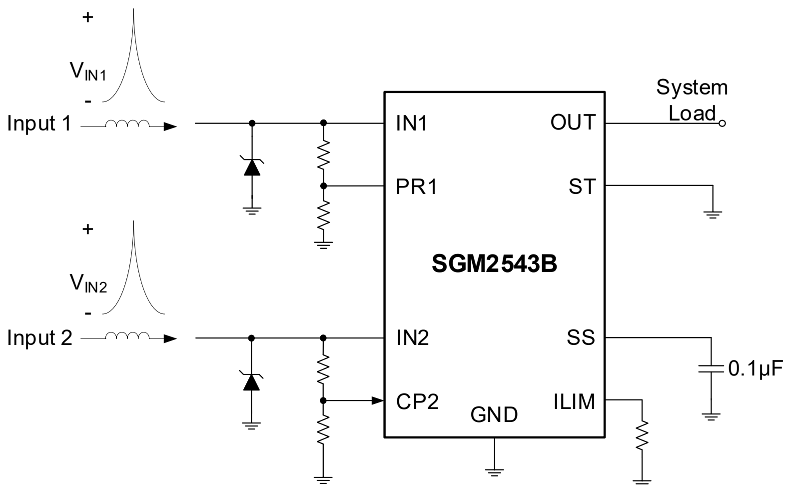
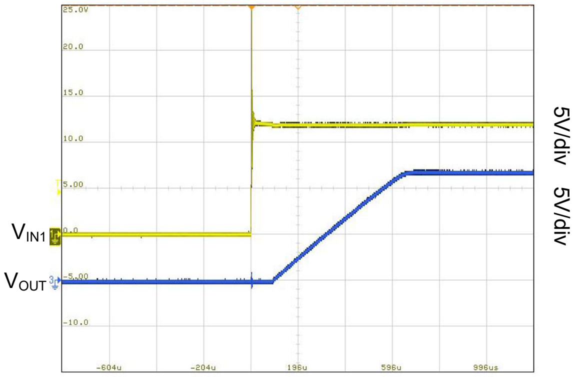


Figure 17. SGM2543B Hot Plug Configuration

The figure shows the waveform of the 12V system hot plug. The 12V power rail is connected to the input port of SGM2543B through a long cable. To suppress voltage spike, TVS will be used. The left figure shows the waveform without using TVS, the spike is over absolute rating voltage. The right figure shows the waveform using SGM15FB1E2, voltage spike was clamped to 19.4V by TVS.

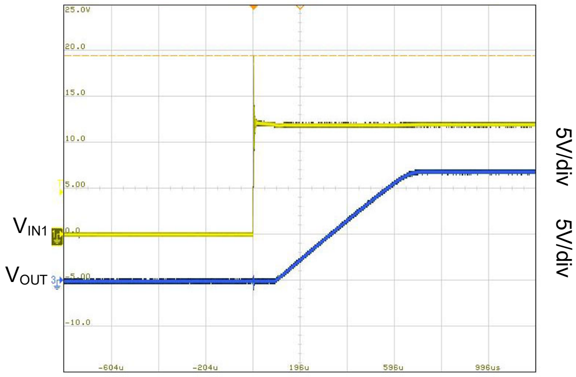
APPLICATION INFORMATION (continued)

Hot Plug Event without TVS



Time (1.5ms/div)

Hot Plug Event with TVS1800



Time (10ms/div)

Layout Guidelines

The power path should be as wide and short as possible, with a current-carrying capacity of more than twice the device's current limit. The INx and OUT pins of the device are used to dissipate heat. Therefore, these pins should be dissipated as much as possible through the copper plane on the top layer or bottom layer on the PCB. Placing thermal vias on the copper plane improves on-resistance as well as current sensing accuracy.

External components of the device as follows should be placed as close to the corresponding pins as possible: R_{ILIM}, C_{SS}, resistor dividers of OV1, OV2, PR1 and CP2. The other end of these components is connected to ground via the shortest possible path. The ILIM pin should have a parasitic capacitance of less than 50pF and the connection path of this pin should be away from the switching signal.

For applications, such as USB-C interfaces, the power cord may be plugged into the input of the device. In this case, the voltage stress of input may exceed the absolute maximum rating, a TVS diode is paralleled at the input port of the device to absorb a positive voltage spike. It is important to note that the loop area formed by the protection components should be as small as possible.

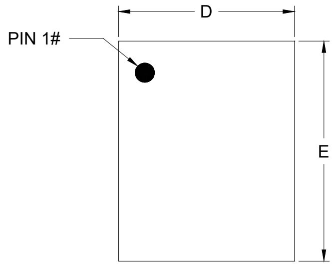
REVISION HISTORY

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

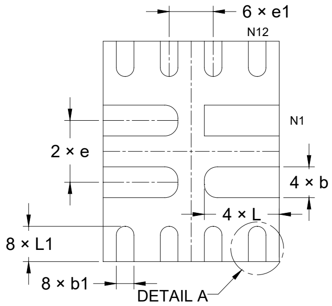
Changes from Original (DECEMBER 2024) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

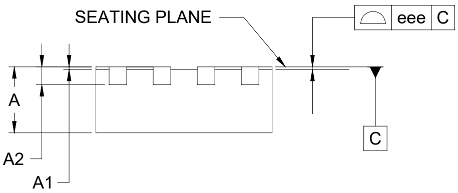
TQFN-2×2.5-12L



TOP VIEW

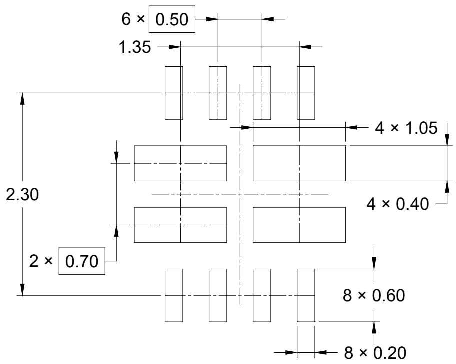


BOTTOM VIEW



SIDE VIEW

DETAIL A
ALTERNATE TERMINAL CONSTRUCTION



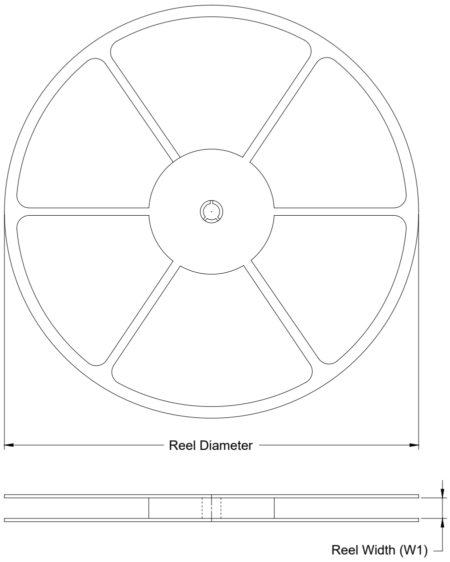
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	0.700	-	0.800
A1	0.000	-	0.050
A2	0.203 REF		
b	0.250	-	0.450
b1	0.150	-	0.250
D	1.900	-	2.100
E	2.400	-	2.600
e	0.700 BSC		
e1	0.500 BSC		
L	0.750	-	0.950
L1	0.300	-	0.500
eee	0.080		

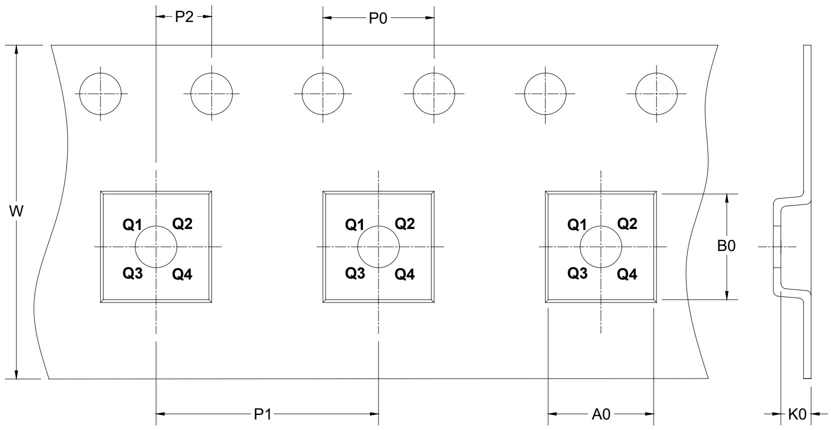
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

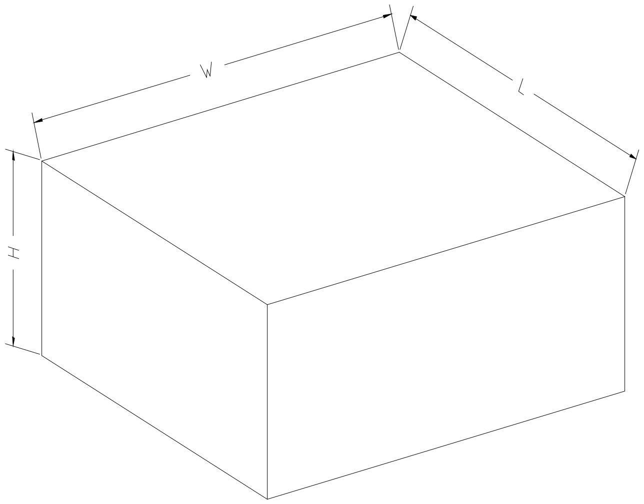
NOTE: The picture is only for reference. Please make the object as the standard.

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
TQFN-2×2.5-12L	7"	9.5	2.25	2.80	1.10	4.0	4.0	2.0	8.0	Q1

DD0001

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

DD0002