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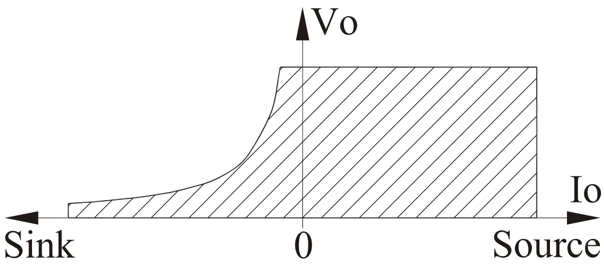
POWER SINK FOR 2 QUADRANT OPERATION options for SM800, SM1500, SM3000 and SM6000

The Power Sink Option permits the power supply to absorb bursts of power fed back to the unit. An internal module senses the status of power supply and sinks current across the output terminals, thus maintaining a constant output voltage.

The Power Sink Option allows a faster response when the power supply is step programmed to a lower voltage at small load conditions.



- Can absorb 10-20% of the unit power. For example, the SM6000 can absorb 700 W.
- Maintains output voltage setting regardless output power is positive or negative (source and sink)
- Ideal solution for supplying electric motors with PWM-speed control. These systems often return power to the power supply during a braking action
- Ideal solution for ATE systems requiring fast down programming at no load conditions
- Generation Automotive waveforms (fast)

Delta Elektronika Power Sinks

See table below for available Delta Elektronika Power Supplies with Power Sink option. All Power Sinks have electronically limited peak power and maximum current. The module shuts down in case of thermal overload (the unit itself continues operation). The overload condition is indicated with a LED on the front panel and with a status output.

SM800 - series *Power Sink* *Peak Power / Maximum current*	**SM7.5-80** *option P245* *140 W / 36 A*	**SM18-50** *option P246* *140 W / 36 A*	**SM70-AR-24** *option P247* *140 W / 25 A*	**SM400-AR-4** *option P248* *140 W / 5 A*	-
SM1500 - series *Power Sink* *Peak Power / Maximum current*	**SM15-100** *option P202* *200 W / 40 A*	**SM35-45** *option P203* *200 W / 40 A*	**SM52-30** *option P204* *200 W / 30 A*	**SM52-AR-60** *option P205* *200 W / 40 A*	**SM70-22** *option P206* *200 W / 30 A*
SM3000 - series *Power Sink* *Peak Power / Maximum current*	**SM15-200D** *option P127* *300 W / 70 A*	**SM30-100D** *option P128* *300 W / 70 A*	**SM45-70D** *option P129* *300 W / 70 A*	**SM70-45D** *option P130* *300 W / 45 A*	-
SM6000 - series *Power Sink* *Peak Power / Maximum current*	**SM15-400** *option P230* *700 W / 140 A*	**SM30-200** *option P231* *700 W / 140 A*	**SM45-140** *option P232* *700 W / 140 A*	**SM60-100** *option P233* *700 W / 100 A*	**SM70-90** *option P234* *700 W / 100 A*

Why does a DC Power Supply need a Power Sink

Modern Loads and Test-Systems become more demanding

In the past a DC power supply only needed to *deliver* power, now loads can *return* power. The only way to cope with this new challenge is integrating an electronic load in the power supply, called a Power Sink. Without the sink-capability the output voltage will start rising and get out of control.

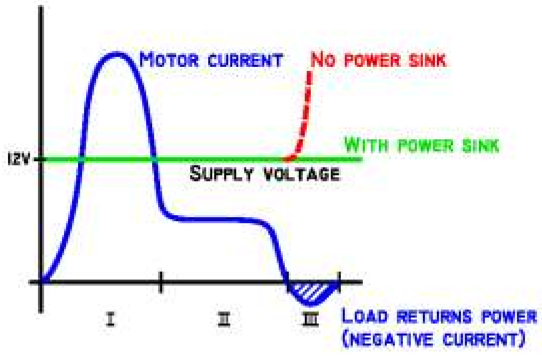


Fig. 1
Typical load current
PWM - controlled DC motor

Reverse Current

DC Motors are more and more controlled by a PWM (Pulse Width Modulation) circuit; the advantage is a flexible loss-less speed control. Car makers make use of this technique to make new solutions possible for pumps, electric steering, brakes, windscreen wipers, hybrid cars and more. Also energy is conserved, this means less heat dissipation. The special behavior of a PWM controlled motor is the return of power during a braking action. In fig. 1 you can see the typical load current, in phase I the motor accelerates; in phase II it has constant speed with a certain load and in phase III the motor brakes and the current becomes negative.

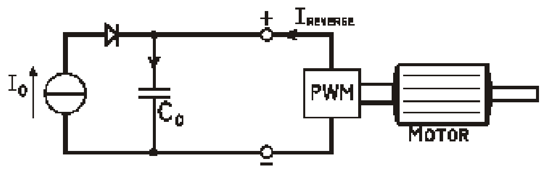


Fig. 2
Simplified output circuit normal power supply.
Braking power of motor charges
output-capacitor

Output under control

Normally the output circuit of a power supply is not designed to absorb current returned by the load; see the simplified circuit in fig. 2. The only path left for the negative load current is into the output capacitor Co, so it will charge and the voltage will rise without any control from the power supply, following the formula dv/dt = i/C. To solve this problem a Power Sink is added, symbolised by the transistor in fig. 3, and integrated in the voltage control of the power supply. So the output voltage is kept to the desired voltage, whether the operation mode is sink or source. Dynamically the system reacts fast, see fig. 5. In this example the load current is switched between positive and negative (a harsh condition). On the output voltage only a slight variation is visible (upper trace). On a normal unit the voltage would rise uncontrolled, see fig. 4.

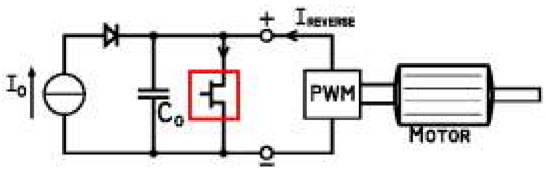


Fig. 3
Braking power of motor absorbed by Power Sink
equipped power supply.
No voltage rise

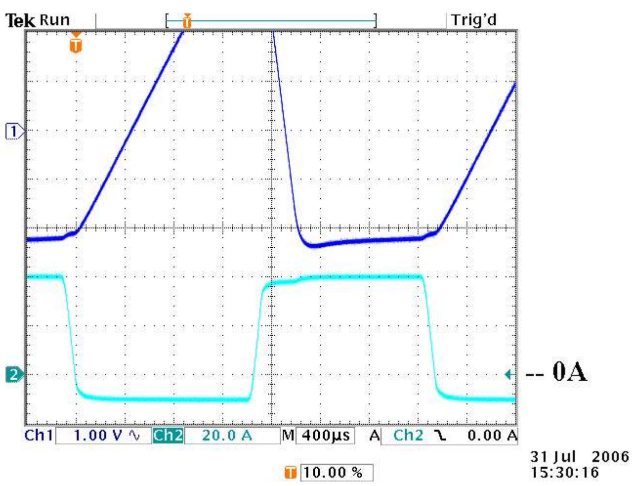


Fig. 4
Without Power Sink
Uncontrolled voltage rise when the load current
goes negative

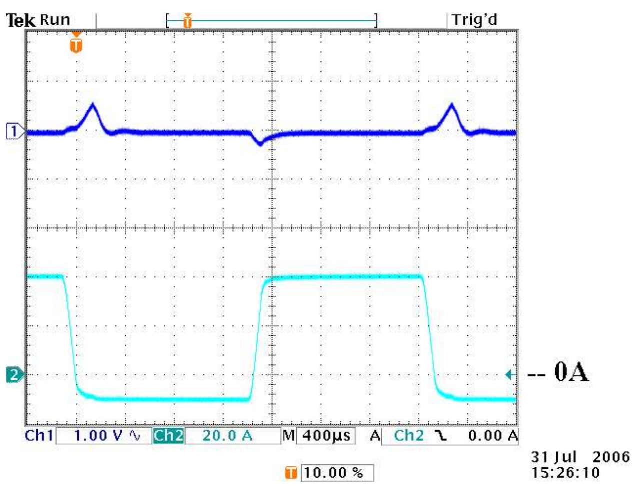


Fig. 5
Dynamics reaction of Power Sink
Load current switches between positive
and negative

Fast Down Programming & Automotive

Test Systems require a test-time as short as possible. For each new item to be tested the voltage often has to be programmed down to zero. A normal power supply has a problem because it cannot quickly discharge the output capacitor Co. The circuit in fig. 6 shows that only the load can discharge Co.

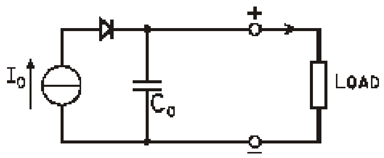


Fig. 6
Simplified output circuit
Normal power supply

A Power Sink as in fig. 7 will make it possible to do fast down-programming at light or no-load conditions. See fig. 8 and fig. 9 to compare the results. Also for generating fast simulation voltages, like the battery voltage of a starting car (ISO7637), a Power Sink is indispensable.

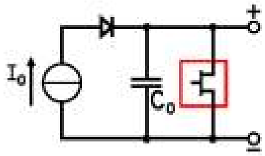


Fig. 7
Simplified output circuit
Power Sink equipped power

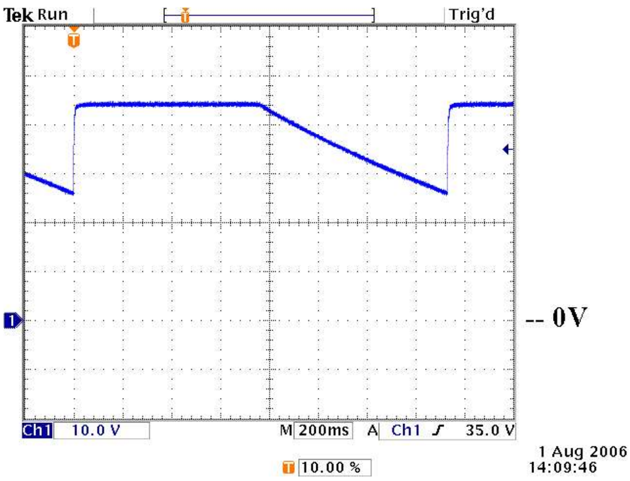


Fig. 8
Down programming at no load
Normal power supply
Voltage falls very slowly

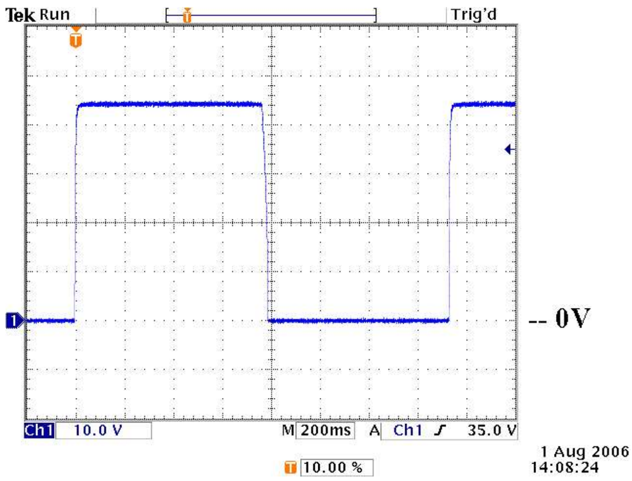


Fig. 9
Down programming at no load
Power Sink equipped power supply
Short fall-time

SM800 - Series

Order code: SM7.5-80 - P245
SM18-50 - P246
SM70-AR-24 - P247
SM400-R-4 - P248

SM70-AR-24

POWER SINK SPECIFICATIONS	SM7.5-80 *option P245*	SM18-50 *option P246*	SM70-AR-24 *option P247*	SM400-AR-4 *option P248*
Sink Power Rating *max. peak power (electronically limited)* *max. continuous power ($T_{amb.}$ = 25 °C)* *max. continuous power ($T_{amb.}$ = 50 °C)*	140 W 140 W 110 W			
Max. duration Sink Peak Power P_{sink} = 140 W, $T_{amb.}$ = 25 °C **Duty Cycle for use at Peak Power** P_{sink} = 140 W, $T_{amb.}$ = 25 °C	continuous 100%			
Max. Sink Current (V_o > = 2 V and P < = 140 W)	Limited at 36 A	Limited at 36 A	Limited at 25 A	Limited at 5 A
Protection	Electronic Power Limit (140 W) limits the current. The temperature of the Power Sink is fan controlled and the circuit shuts down in case of thermal overload.			
Recovery time / Deviation				
Vo = 6 V, I_o: +30 A → –10 A *recovery within 100 mV / deviation:*	di/dt = – 0.7 A/µs 200 µs / 0.15 V	di/dt = – 0.7 A/µs 400 µs / 0.25 V	-	-
Vo = 15 V, I_o: +20 A → –4 A *recovery within 100 mV / deviation:*	-	di/dt = – 0.5 A/µs 700 µs / 0.20 V	di/dt = – 0.5 A/µs 700 µs / 0.85 V	-
Vo = 24 V, I_o: +15 A → –2 A *recovery within 100 mV / deviation:*	-	-	di/dt = – 0.4 A/µs 800 µs / 0.75 V	-
Vo = 60 V, I_o: +9 A → –1 A *recovery within 100 mV / deviation:*	-	-	di/dt =– 0.3 A/µs 4.0 ms / 0.65 V	-
Vo = 150 V, I_o: +3 A → –0.5 A *recovery within 1.0 V / deviation:*	-	-	-	di/dt = – 0.1 A/µs 800 µs/ 4.0 V
Vo = 350 V, I_o: +1 A → –0.1 A *recovery within 1.0 V / deviation:*	-	-	-	di/dt = – 0.05 A/µs 2.0 ms / 2.7 V
(load current switches from positive to negative)	*note: values are typical*	*note: values are typical*	*note: values are typical*	*note: values are typical*
Programming Down Speed *Fall time at **no load** (90 - 10%)* *Fall time at no load without Power Sink*	(7.5 → 0 V) 6.5 ms 5 s	(18 → 0 V) 17 ms 6 s	(70 → 0 V) 25 ms 4 s	(400 → 0 V) 19 ms 4.5 s
Unit with Fast Programming Option *Fall time at **no load** (90 - 10%)* *Fall time at no load without Power Sink*	***P245+P250*** *specifications not yet available*	***P246+P251*** *specifications not yet available*	***P247+P252*** 1 ms 760 ms	***P248+P253*** *specifications not yet available*

Notes:

- *The maximum sink current at higher voltages will not be the maximum specified current due to the power limit. For example at 30 V the maximum sink current will only be 4.7 A (30 V x 4.7 A = 140 W = maximum power).*
- *A higher sink current than the maximum current will cause the output voltage to rise.*

SM1500 - Series

Order code: SM15-100 - P202
SM35-45 - P203
SM52-30 - P204
SM52-AR-60 - P205
SM70-22 - P206

SM52-AR-60

POWER SINK SPECIFICATIONS	SM15-100 *option P202*	SM35-45 *option P203*	SM52-30 *option P204*	SM52-AR-60 *option P205*	SM70-22 *option P206*
Sink Power Rating *max. peak power (electronically limited)* *max. continuous power ($T_{amb.}$ = 25 °C)* *max. continuous power ($T_{amb.}$ = 50 °C)*	200 W 125 W 80 W				
Max. duration Sink Peak Power P_{sink} = 200 W, $T_{amb.}$ = 25 °C **Duty Cycle for use at Peak Power** P_{sink} = 200 W, $T_{amb.}$ = 25 °C P_{sink} < = 200 W, T_{on} < = 20 s t_{on} = time, power dissipation is > 0 W t_{off} = time, power dissipation is 0 W $P_{av} = P_{peak} * t_{on} / (t_{off} + t_{on})$	max.t_{on} = 60 s, following t_{off} = 500 s (for cooling down) t_{on} < = 20 s / t_{off} > = 14 s average power < = 130 W				
Max. Sink Current *(V_O >= 2 V and P <= 200 W)*	Limited at 40 A	Limited at 40 A	Limited at 30 A	Limited at 40 A	Limited at 30 A
Protection	Electronic Power Limit (200 W) limits the current. The temperature of the Power Sink is fan controlled and the circuit shuts down in case of thermal overload.				
Recovery time / Deviation					
Vo = 6 V, I_O: +40 A → –15 A *recovery within 100 mV / deviation:*	di/dt= –1.7A/µs 300 µs / 0.20V	di/dt= –1.7A/µs 500 µs / 0.45V	-	di/dt = –1.7A/µs 700 µs / 0.50V	-
Vo = 15 V, I_O: +25 A → –8 A *recovery within 100 mV / deviation:*	di/dt= –1.6A/µs 500 µs / 0.15V	di/dt= –1.6A/µs 600 µs / 0.40V	di/dt= – 1.6A/µs 640 µs / 0.70V	di/dt = –1.3A/µs 900 µs / 0.45V	-
Vo = 35 V, I_O: +20 A → –3 A *recovery within 100 mV / deviation:*	-	di/dt= –1.3A/µs 1.10ms / 0.35V	di/dt = –1.3A/µs 800 µs / 0.60V	di/dt=–0.83A/µs 1.30ms / 0.35V	di/dt= –1.3A/µs 800 µs/0.70V
Vo = 52 V, I_O: +10 A → –2 A *recovery within 100 mV / deviation:*	-	-	di/dt = –0.7A/µs 800 µs / 0.60V	di/dt = –0.6A/µs 1.90ms / 0.35V	di/dt=–0.6A/µs 1.00ms /0.70V
Vo = 70 V, I_O: +10 A → –1 A *recovery within 100 mV / deviation:*	-	-	-	-	di/dt= –0.6A/µs 1.20ms / 0.50V
(load current switches from positive to negative)	*note: values are typical*	*note: values are typical*	*note: values are typical*	*note: values are typical*	*note: values are typical*
Programming Down Speed *Fall time at **no load** (90 - 10%)* *Fall time at no load without Power Sink*	(15 → 0 V) 8 ms 2 s	(35 → 0 V) 18 ms 5.5 s	(52 → 0 V) 10 ms 4 s	(52 → 0 V) 45 ms 7.5 s	(70 → 0 V) 18 ms 5.5 s
Parallel and Series operation Refer to Power Sink manual for details and restrictions	Using multiple units in parallel operation, only one unit can have a Power Sink. Using multiple units in series operation, all units must have a Power Sink.				

Notes:

- *The maximum sink current at higher voltages will not be the maximum specified current due to the power limit. For example at 30 V the maximum sink current will only be 6.7 A (30 V x 6.7 A = 200 W = maximum power).*
- *A higher sink current than the maximum current will cause the output voltage to rise.*

SM3000 - Series

Order code: SM15-200D - P127
SM30-100D - P128
SM45-70D - P129
SM70-45D - P130

SM30-100D

POWER SINK SPECIFICATIONS	SM15-200D *option P127*	SM30-100D *option P128*	SM45-70D *option P129*	SM70-45D *option P130*
Sink Power Rating				
max. peak power (electronically limited)	300 W			
max. continuous power ($T_{amb.}$ = 25 °C)	30 W			
max. continuous power ($T_{amb.}$ = 50 °C)	15 W			
Max. duration Sink Peak Power P_{sink} = 300 W, $T_{amb.}$ = 25 °C	max.t_{on} = 60 s, following t_{off} = 1200 s (for cooling down)			
Duty Cycle for use at Peak Power P_{sink} = 300 W, $T_{amb.}$ = 25 °C; P_{sink} < = 300 W, T_{on} < = 15 s	t_{on} < = 15 s / t_{off} > = 150 s average power < = 30 W			
t_{on} = time, power dissipation is > 0 W; t_{off} = time, power dissipation is 0 W; $P_{av} = P_{peak} * t_{on} / (t_{off} + t_{on})$				
Max. Sink Current (V_O > = 2 V and P < = 300 W)	Limited at 70 A			Limited at 45 A
Protection	Electronic Power Limit (300 W) limits the current. Sink circuit shuts down in case of thermal overload.			
Recovery time / Deviation				
Vo = 6 V, I_O: +80 A → –20 A recovery within 100 mV / deviation:	di/dt = – 1.5 A/µs 200 µs / 0.30 V	di/dt = – 1.5 A/µs 300 µs / 0.60 V	-	-
Vo = 15 V, I_O: +40 A → –10 A recovery within 100 mV / deviation:	di/dt = – 1.0 A/µs 500 µs / 0.15 V	di/dt = – 0.9 A/µs 350 µs / 0.30 V	di/dt = – 0.9 A/µs 200 µs / 0.45 V	di/dt = – 0.9 A/µs 200 µs/ 0.75 V
Vo = 24 V, I_O: +20 A → –6 A recovery within 100 mV / deviation:	-	di/dt = – 0.5 A/µs 500 µs / 0.30 V	di/dt = – 0.6 A/µs 200 µs / 0.40 V	di/dt = – 0.6 A/µs 200 µs / 0.45 V
Vo = 42 V, I_O: +20 A → –3.5 A recovery within 100 mV / deviation:	-	-	di/dt =– 0.6 A/µs 500 µs / 0.45 V	di/dt = – 0.6 A/µs 480 µs / 0.45 V
Vo = 60 V, I_O: +10 A → –2.5 A recovery within 1.0 V / deviation:	-	-	-	di/dt = – 0.3 A/µs 1.0 ms / 0.50 V
(load current switches from positive to negative)	*note: values are typical*	*note: values are typical*	*note: values are typical*	*note: values are typical*
Programming Down Speed	(15 → 0 V)	(30 → 0 V)	(45 → 0 V)	(70 → 0 V)
Fall time at **no load** (90 - 10%)	6 ms	10 ms	6 ms	10 ms
Fall time at no load *without Power Sink*	6 s	8 s	2 s	5 s
Parallel and Series operation Refer to Power Sink manual for details and restrictions.	Using multiple units in parallel operation, only one unit can have a Power Sink. Using multiple units in series operation, all units must have a Power Sink.			

Notes:

- *The maximum sink current at higher voltages will not be the maximum specified current due to the power limit. For example at 30 V the maximum sink current will only be 10 A (30 V x 10 A = 300 W = maximum power).*
- *A higher sink current than the maximum current will cause the output voltage to rise.*

SM6000 - Series


SM15-400

Order code:
SM15-400 - P230
SM30-200 - P231
SM45-140 - P232
SM60-100 - P233
SM70-90 - P234

POWER SINK SPECIFICATIONS	SM15-400 *option P230*	SM30-200 *option P231*	SM45-140 *option P232*	SM60-100 *option P233*	SM70-90 *option P234*
Sink Power Rating *max. peak power (electronically limited)* *max. continuous power ($T_{amb.}$ = 25 °C)* *max. continuous power ($T_{amb.}$ = 50 °C)*	700 W 550 W 275 W				
Max. duration Sink Peak Power P_{sink} = 700 W, $T_{amb.}$ = 25 °C	max.t_{on} = 80 s, following t_{off} = 600 s (for cooling down)				
Duty Cycle for use at Peak Power P_{sink} = 700 W, $T_{amb.}$ = 25 °C P_{sink} < = 700 W, T_{on} < = 40 s t_{on} = time, power dissipation is > 0 W t_{off} = time, power dissipation is 0 W $P_{av} = P_{peak} * t_{on} / (t_{off} + t_{on})$	t_{on} < = 40 s / t_{off} > = 12 s average power < = 550 W				
Max. Sink Current *(V_o > = 2 V and P < = 700 W)*	Limited at 140 A			Limited at 100 A	
Protection	Electronic Power Limit (700 W) limits the current. The temperature of the Power Sink is fan controlled and the circuit shuts down in case of thermal overload.				
Recovery time / Deviation *Vo = 6 V, I_O: + 200 A → – 80 A* *recovery within 100 mV / deviation:*	di/dt= –5A/µs 250 µs / 0.40V	di/dt= –5A/µs 350 µs / 0.75V	-	-	-
Vo = 15 V, I_O: + 90 A → – 30 A *recovery within 100 mV / deviation:*	di/dt= –3.5A/µs 550 µs / 0.25V	di/dt= –3.5A/µs 550 µs / 0.45V	di/dt= – 3.5A/µs 650 µs / 0.90V	di/dt = –3.5A/µs 650 µs / 1.10V	di/dt= –3.5A/µs 650 µs / 1.10V
Vo = 24 V, I_O: + 50 A → – 12 A *recovery within 100 mV / deviation:*	-	di/dt= –1.8A/µs 650ms / 0.36V	di/dt = –1.8A/µs 750 µs / 0.60V	di/dt = –1.8A/µs 750 µs / 0.70V	di/dt= –1.8A/µs 800 µs/0.75V
Vo = 42 V, I_O: + 20 A → – 10 A *recovery within 100 mV / deviation:*	-	-	di/dt = –1.2A/µs 880 µs / 0.75V	di/dt=–1.2A/µs 880 µs / 0.80V	di/dt=–1.2A/µs 900 µs /0.80V
Vo = 60 V, I_O: + 20 A → – 5 A *recovery within 100 mV / deviation:*	-	-	-	di/dt = –0.9A/µs 1.2ms / 0.70V	di/dt= –0.9A/µs 1.2ms / 0.70V
(load current switches from positive to negative)	*note: values are typical*	*note: values are typical*	*note: values are typical*	*note: values are typical*	*note: values are typical*
Programming Down Speed *Fall time at **no load** (90 - 10%)* *Fall time at no load without Power Sink*	(15 → 0 V) 6 ms 3.5 s	(30 → 0 V) 10 ms 5.5 s	(45 → 0 V) 4.5 ms 3 s	(60 → 0 V) 9.5 ms 5.5 s	(70 → 0 V) 10.5 ms 6 s
Parallel and Series operation Refer to Power Sink manual for details and restrictions	Using multiple units in parallel operation, only one unit can have a Power Sink. Using multiple units in series operation, all units must have a Power Sink.				

Notes:

- *The maximum sink current at higher voltages will not be the maximum specified current due to the power limit. For example at 30 V the maximum sink current will only be 24 A (30V x 24A = 700W = maximum power).*
- *A higher sink current than the maximum current will cause the output voltage to rise.*