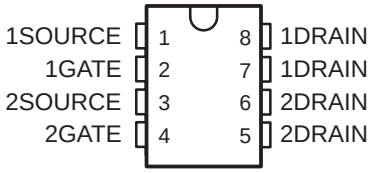
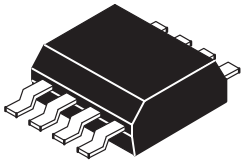
SLVS080A – MARCH 1994 – REVISED AUGUST 1995

- **Low $r_{DS(on)}$ . . . 0.18 Ω at V_{GS} = –10 V**
- **3-V Compatible**
- **Requires No External V_{CC}**
- **TTL and CMOS Compatible Inputs**
- **$V_{GS(th)}$ = –1.5 V Max**
- **ESD Protection Up to 2 kV per MIL-STD-883C, Method 3015**

D PACKAGE
(TOP VIEW)





description

The TPS1120 incorporates two independent p-channel enhancement-mode MOSFETs that have been optimized, by means of the Texas Instruments LinBiCMOS™ process, for 3-V or 5-V power distribution in battery-powered systems. With a maximum $V_{GS(th)}$ of –1.5 V and an I_{DSS} of only 0.5 µA, the TPS1120 is the ideal high-side switch for low-voltage portable battery-management systems, where maximizing battery life is a primary concern. Because portable equipment is potentially subject to electrostatic discharge (ESD), the MOSFETs have built-in circuitry for 2-kV ESD protection. End equipment for the TPS1120 includes notebook computers, personal digital assistants (PDAs), cellular telephones, bar-code scanners, and PCMCIA cards. For existing designs, the TPS1120D has a pinout common with other p-channel MOSFETs in small-outline integrated circuit SOIC packages.

The TPS1120 is characterized for an operating junction temperature range, T_J, from –40°C to 150°C.

AVAILABLE OPTIONS

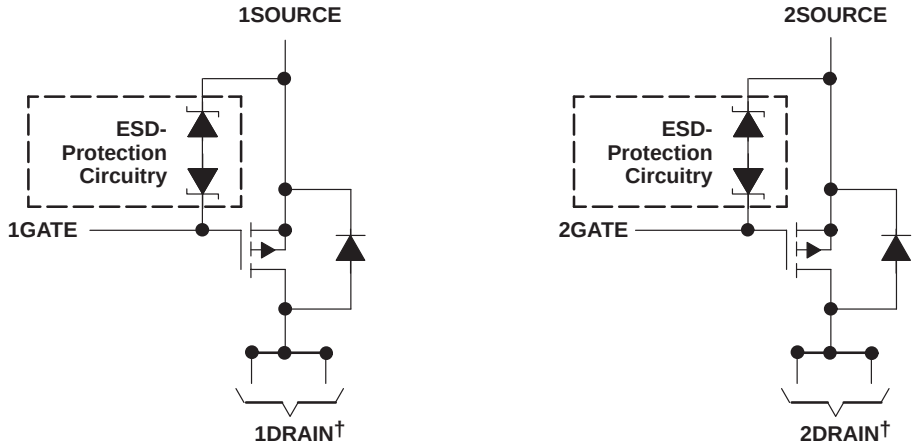
T_J	PACKAGED DEVICES†	CHIP FORM (Y)
	SMALL OUTLINE (D)	
–40°C to 150°C	TPS1120D	TPS1120Y

† The D package is available taped and reeled. Add an R suffix to device type (e.g., TPS1120DR). The chip form is tested at 25°C.

Caution. This device contains circuits to protect its inputs and outputs against damage due to high static voltages or electrostatic fields. These circuits have been qualified to protect this device against electrostatic discharges (ESD) of up to 2 kV according to MIL-STD-883C, Method 3015; however, it is advised that precautions be taken to avoid application of any voltage higher than maximum-rated voltages to these high-impedance circuits.

LinBiCMS is a trademark of Texas Instruments Incorporated.

schematic

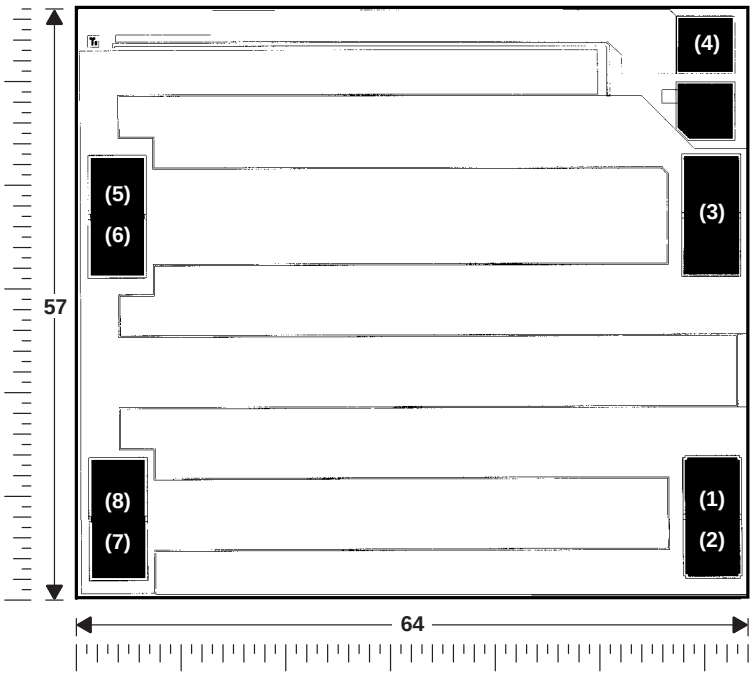


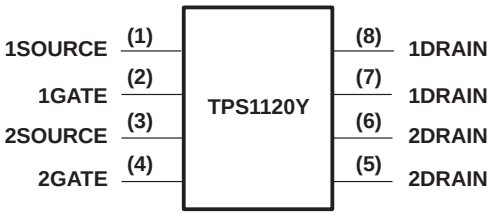
† For all applications, both drain pins for each device should be connected.

TPS1120Y chip information

This chip, when properly assembled, displays characteristics similar to the TPS1120C. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. The chip may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 15 MILS TYPICAL

BONDING PADS: 4 × 4 MILS MINIMUM

$T_J$max = 150°C

TOLERANCES ARE ±10%

ALL DIMENSIONS ARE IN MILS

absolute maximum ratings over operating free-air temperature (unless otherwise noted)†

				UNIT
Drain-to-source voltage, V_{DS}			–15	V
Gate-to-source voltage, V_{GS}			2 or –15	V
Continuous drain current, each device (T_J = 150°C), I_D	V_{GS} = –2.7 V	T_A = 25°C	±0.39	A
		T_A = 125°C	±0.21	
	V_{GS} = –3 V	T_A = 25°C	±0.5	
		T_A = 125°C	±0.25	
	V_{GS} = –4.5 V	T_A = 25°C	±0.74	
		T_A = 125°C	±0.34	
	V_{GS} = –10 V	T_A = 25°C	±1.17	
		T_A = 125°C	±0.53	
Pulse drain current, I_D		T_A = 25°C	±7	A
Continuous source current (diode conduction), I_S		T_A = 25°C	–1	A
Continuous total power dissipation		See Dissipation Rating Table		
Storage temperature range, T_{stg}			–55 to 150	°C
Operating junction temperature range, T_J			–40 to 150	°C
Operating free-air temperature range, T_A			–40 to 125	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds			260	°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR‡ ABOVE T_A = 25°C	T_A = 70°C POWER RATING	T_A = 85°C POWER RATING	T_A = 125°C POWER RATING
D	840 mW	6.71 mW/°C	538 mW	437 mW	169 mW

‡ Maximum values are calculated using a derating factor based on $R_{\theta JA}$ = 149°C/W for the package. These devices are mounted on an FR4 board with no special thermal considerations.

electrical characteristics at T_J = 25°C (unless otherwise noted)

static

PARAMETER		TEST CONDITIONS		TPS1120			UNIT
				MIN	TYP	MAX	
$V_{GS(th)}$	Gate-to-source threshold voltage	V_{DS} = V_{GS},	I_D = –250 µA	–1	–1.25	–1.50	V
V_{SD}	Source-to-drain voltage (diode forward voltage)†	I_S = –1 A,	V_{GS} = 0 V		–0.9		V
I_{GSS}	Reverse gate current, drain short circuited to source	V_{DS} = 0 V,	V_{GS} = –12 V			±100	nA
I_{DSS}	Zero-gate-voltage drain current	V_{DS} = –12 V, V_{GS} = 0 V	T_J = 25°C			–0.5	µA
			T_J = 125°C			–10	
$r_{DS(on)}$	Static drain-to-source on-state resistance†	V_{GS} = –10 V	I_D = –1.5 A		180		mΩ
		V_{GS} = –4.5 V	I_D = –0.5 A		291	400	
		V_{GS} = –3 V	I_D = –0.2 A		476	700	
		V_{GS} = –2.7 V			606	850	
g_{fs}	Forward transconductance†	V_{DS} = –10 V,	I_D = –2 A		2.5		S

† Pulse test: pulse width ≤ 300 µs, duty cycle ≤ 2%

static

PARAMETER		TEST CONDITIONS		TPS1120Y			UNIT
				MIN	TYP	MAX	
$V_{GS(th)}$	Gate-to-source threshold voltage	V_{DS} = V_{GS},	I_D = –250 µA		–1.25		V
V_{SD}	Source-to-drain voltage (diode forward voltage)†	I_S = –1 A,	V_{GS} = 0 V		–0.9		V
$r_{DS(on)}$	Static drain-to-source on-state resistance†	V_{GS} = –10 V	I_D = –1.5 A		180		mΩ
		V_{GS} = –4.5 V	I_D = –0.5 A		291		
		V_{GS} = –3 V	I_D = –0.2 A		476		
		V_{GS} = –2.7 V			606		
g_{fs}	Forward transconductance†	V_{DS} = –10 V,	I_D = –2 A		2.5		S

† Pulse test: pulse width ≤ 300 µs, duty cycle ≤ 2%

dynamic

PARAMETER		TEST CONDITIONS			TPS1120, TPS1120Y			UNIT
					MIN	TYP	MAX	
Q_g	Total gate charge	V_{DS} = –10 V,	V_{GS} = –10 V,	I_D = –1 A		5.45		nC
Q_{gs}	Gate-to-source charge					0.87		
Q_{gd}	Gate-to-drain charge					1.4		
$t_{d(on)}$	Turn-on delay time	V_{DD} = –10 V, R_G = 6 Ω,	R_L = 10 Ω, See Figures 1 and 2	I_D = –1 A,		4.5		ns
$t_{d(off)}$	Turn-off delay time					13		ns
t_r	Rise time					10		ns
t_f	Fall time					2		
$t_{rr(SD)}$	Source-to-drain reverse recovery time	I_F = 5.3 A,	di/dt = 100 A/µs			16		

PARAMETER MEASUREMENT INFORMATION

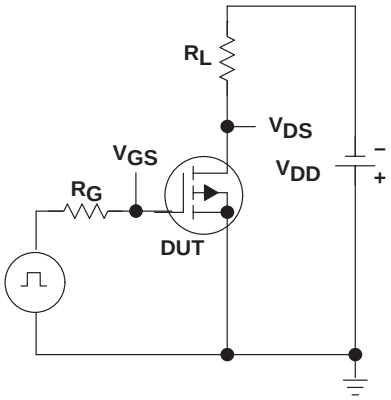


Figure 1. Switching-Time Test Circuit

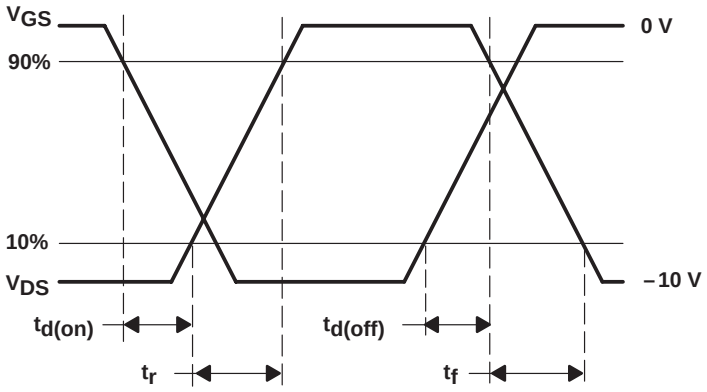


Figure 2. Switching-Time Waveforms

TYPICAL CHARACTERISTICS†

Table of Graphs

		FIGURE
Drain current	vs Drain-to-source voltage	3
Drain current	vs Gate-to-source voltage	4
Static drain-to-source on-state resistance	vs Drain current	5
Capacitance	vs Drain-to-source voltage	6
Static drain-to-source on-state resistance (normalized)	vs Junction temperature	7
Source-to-drain diode current	vs Source-to-drain voltage	8
Static drain-to-source on-state resistance	vs Gate-to-source voltage	9
Gate-to-source threshold voltage	vs Junction temperature	10
Gate-to-source voltage	vs Gate charge	11

DRAIN CURRENT vs DRAIN-TO-SOURCE VOLTAGE

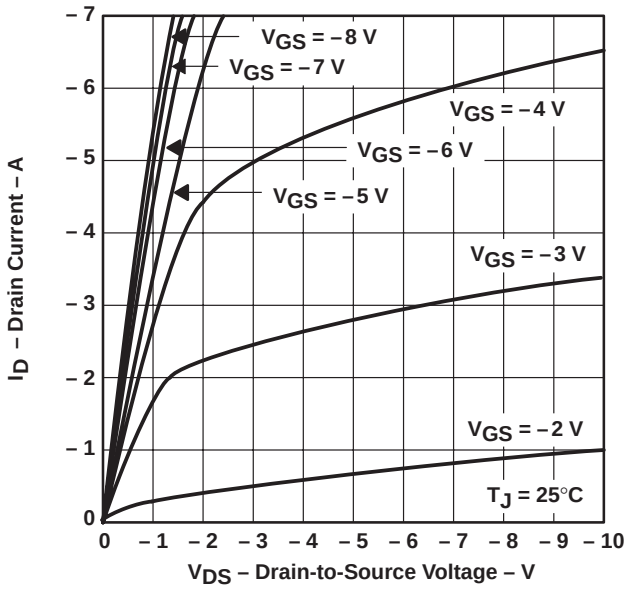


Figure 3

DRAIN CURRENT vs GATE-TO-SOURCE VOLTAGE

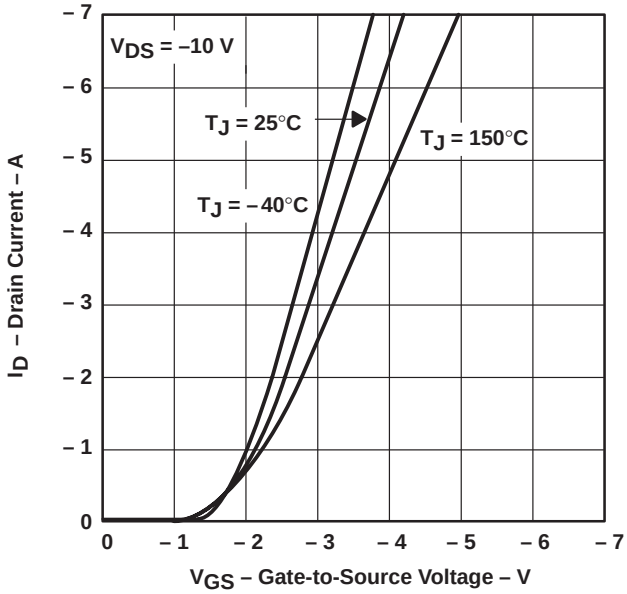


Figure 4

† All characteristics data applies for each independent MOSFET incorporated on the TPS1120.

TYPICAL CHARACTERISTICS

STATIC DRAIN-TO-SOURCE ON-STATE RESISTANCE vs DRAIN CURRENT

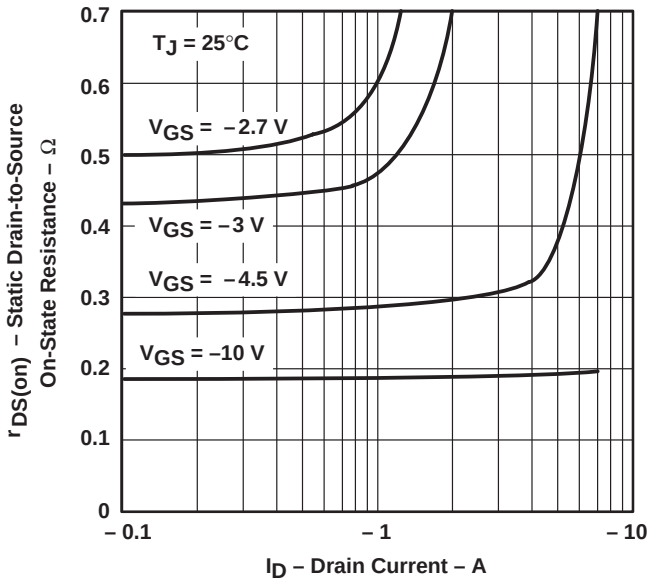
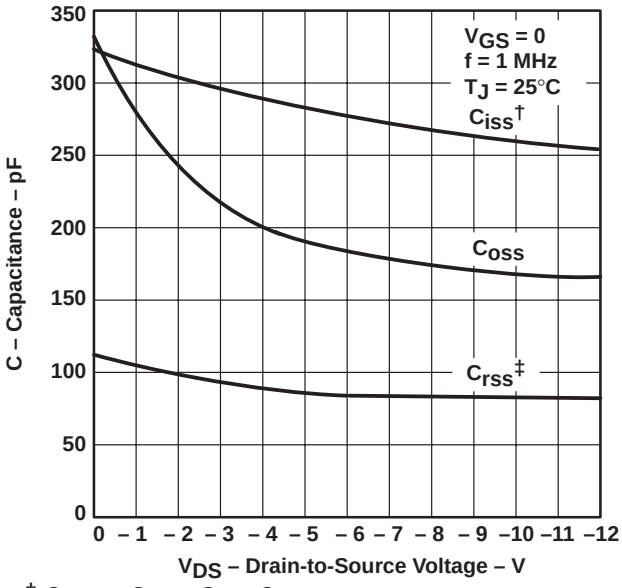


Figure 5

CAPACITANCE vs DRAIN-TO-SOURCE VOLTAGE



† $C_{iss} = C_{gs} + C_{gd}$, $C_{ds(shorted)}$

‡ $C_{rss} = C_{gd}$, $C_{oss} = C_{ds} + \dfrac{C_{gs}\,C_{gd}}{C_{gs} + C_{gd}} \approx C_{ds} + C_{gd}$

Figure 6

STATIC DRAIN-TO-SOURCE ON-STATE RESISTANCE (NORMALIZED) vs JUNCTION TEMPERATURE

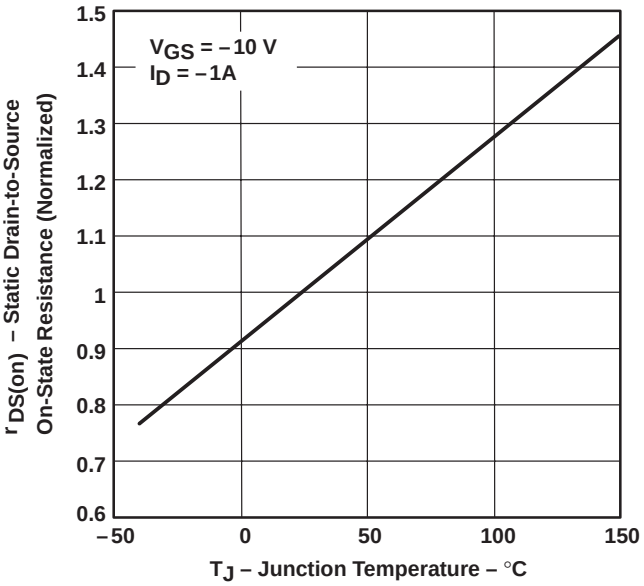


Figure 7

SOURCE-TO-DRAIN DIODE CURRENT vs SOURCE-TO-DRAIN VOLTAGE

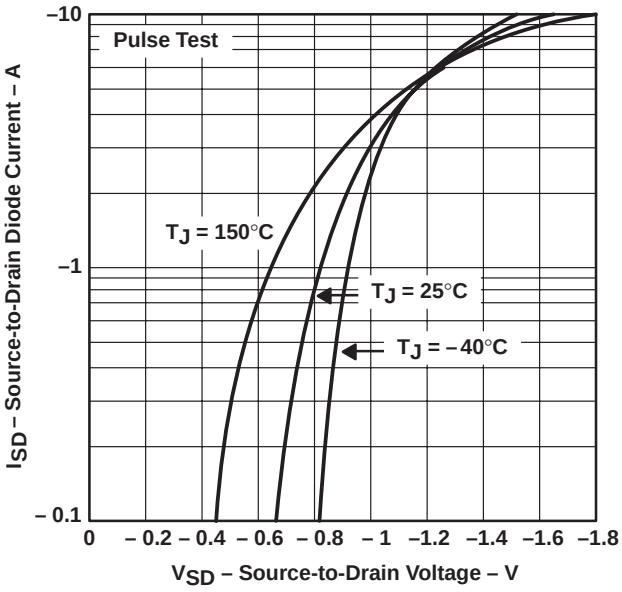


Figure 8

TYPICAL CHARACTERISTICS

STATIC DRAIN-TO-SOURCE ON-STATE RESISTANCE vs GATE-TO-SOURCE VOLTAGE

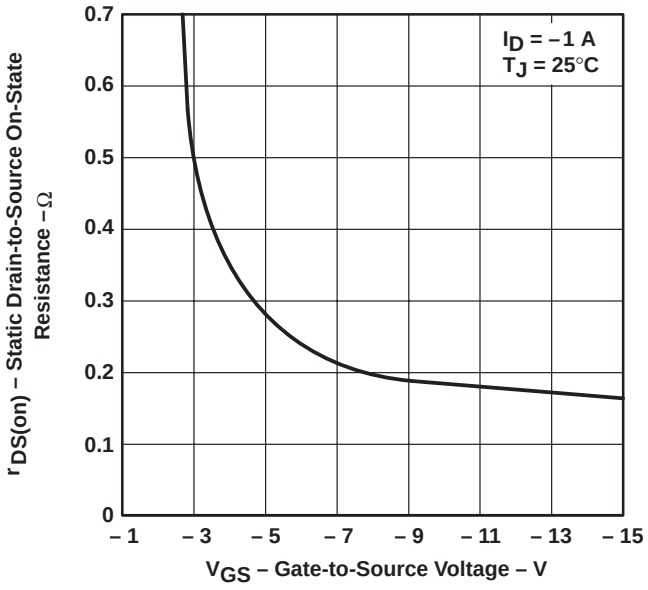


Figure 9

GATE-TO-SOURCE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

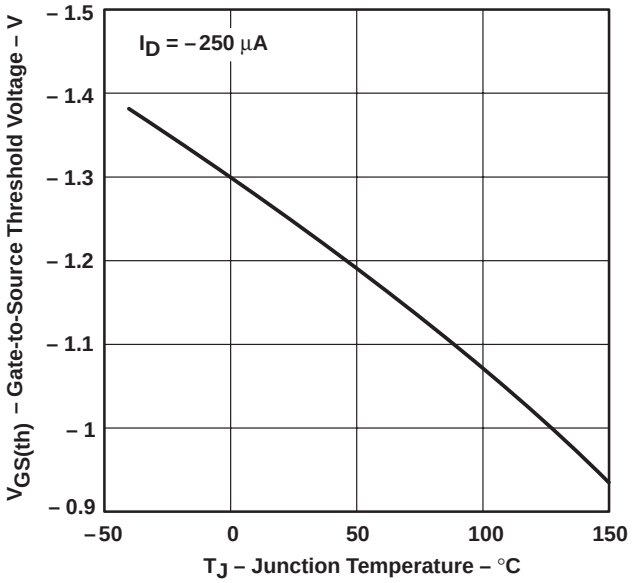


Figure 10

GATE-TO-SOURCE VOLTAGE vs GATE CHARGE

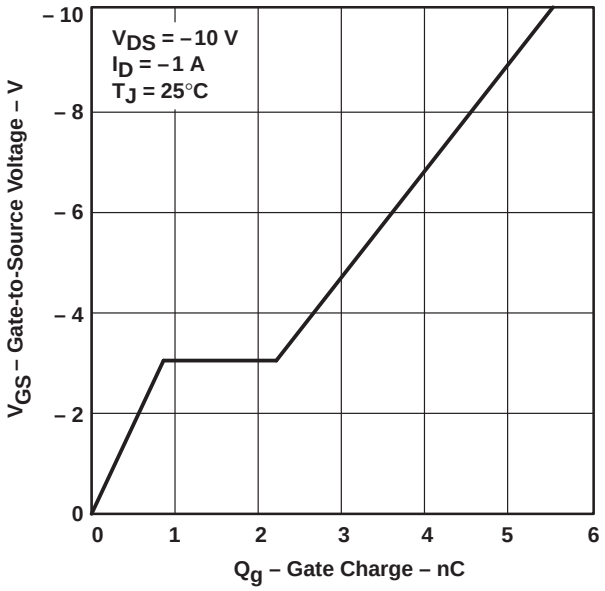
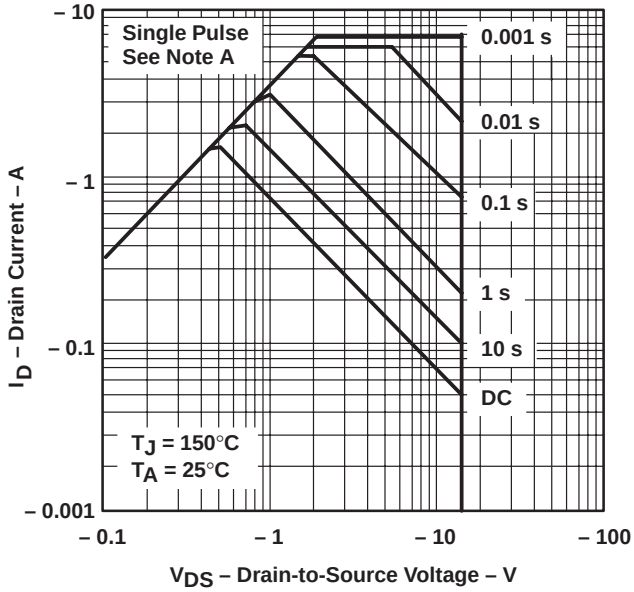


Figure 11

THERMAL INFORMATION

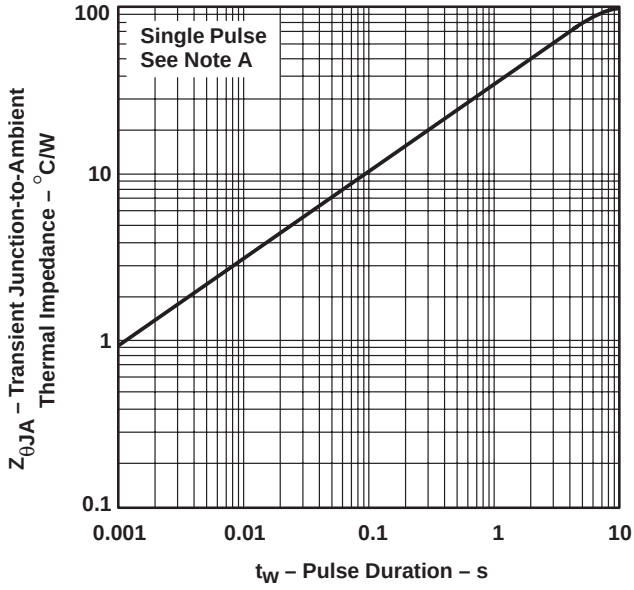
DRAIN CURRENT
vs
DRAIN-TO-SOURCE VOLTAGE



NOTE A: FR4-board-mounted only

Figure 12

TRANSIENT JUNCTION-TO-AMBIENT
THERMAL IMPEDANCE
vs
PULSE DURATION



NOTE A: FR4-board-mounted only

Figure 13

THERMAL INFORMATION

The profile of the heat sinks used for thermal measurements is shown in Figure 14. Board type is FR4 with 1-oz copper and 1-oz tin/lead (63/37) plate. Use of vias or through-holes to enhance thermal conduction was avoided.

Figure 15 shows a family of $R_{\theta JA}$ curves. The $R_{\theta JA}$ was obtained for various areas of heat sinks while subject to air flow. Power remained fixed at 0.25 W per device or 0.50 W per package. This testing was done at 25°C.

As Figure 14 illustrates, there are two separated heat sinks for each package. Each heat sink is coupled to the lead that is internally tied to a single MOSFET source and is half the total area, as shown in Figure 15. For example, if the total area shown in Figure 15 is 4 cm^2, each heat sink is 2 cm^2.

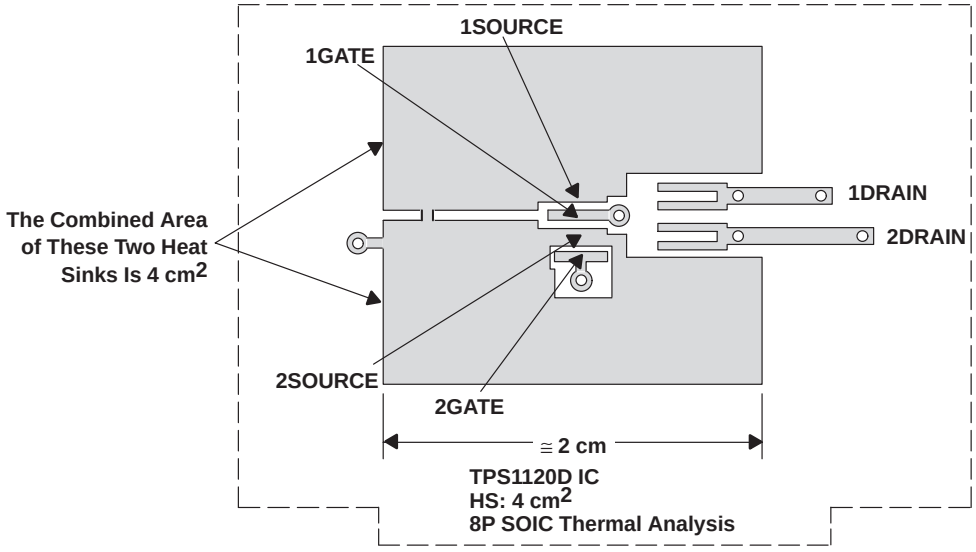


Figure 14. Profile of Heat Sinks

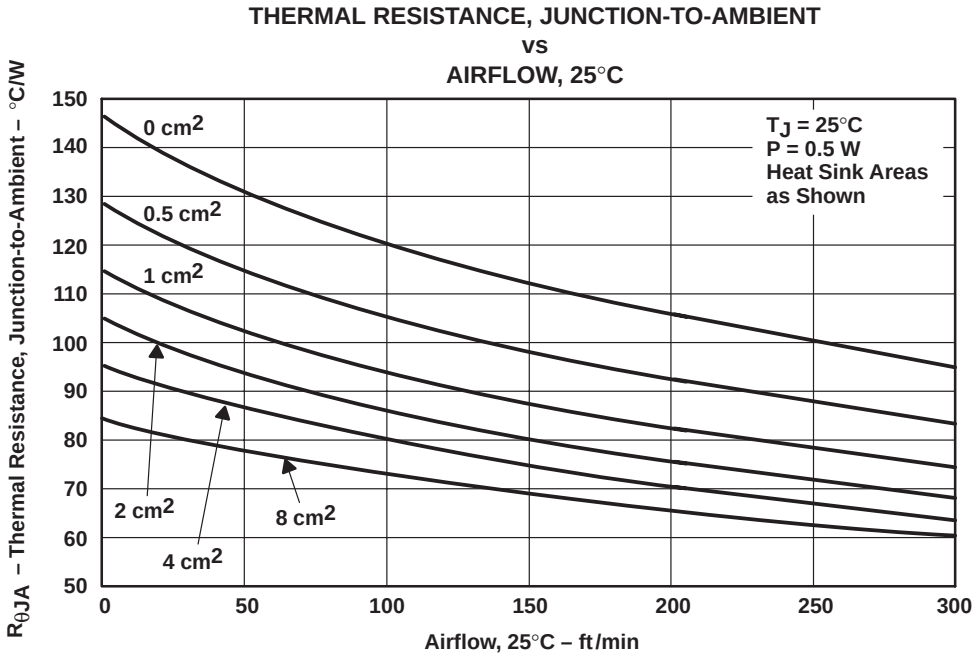


Figure 15

THERMAL INFORMATION

Figure 16 illustrates the thermally enhanced (SO) lead frame. Attaching the two MOSFET dies directly to the source terminals allows maximum heat transfer into a power plane.

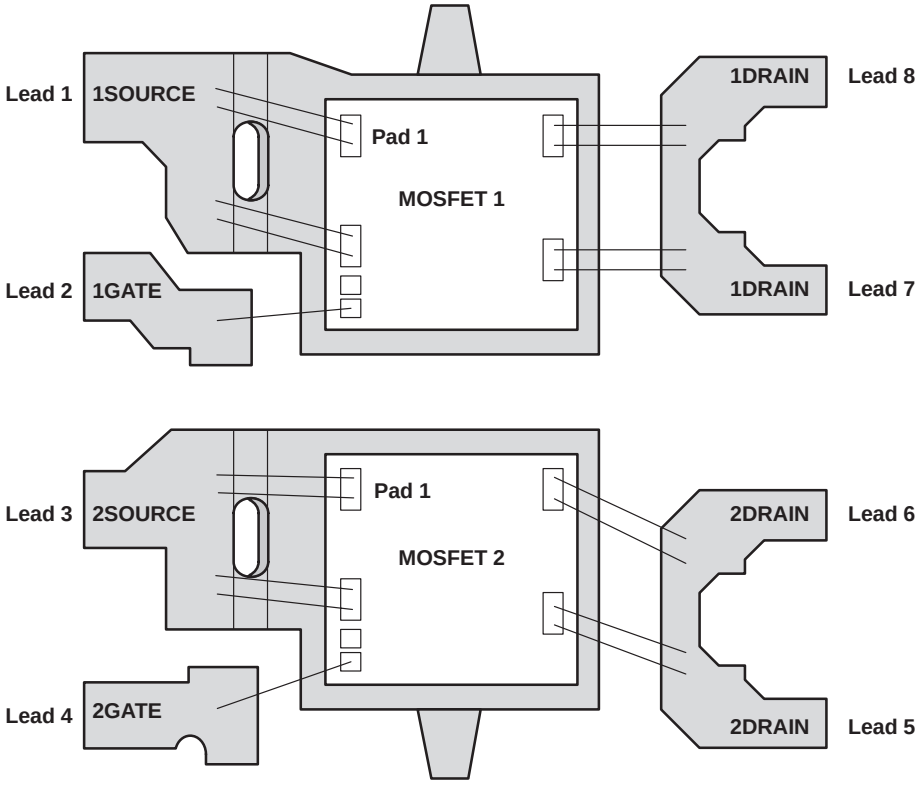


Figure 16. TPS1120 Dual MOSFET SO-8 Lead Frame

APPLICATION INFORMATION

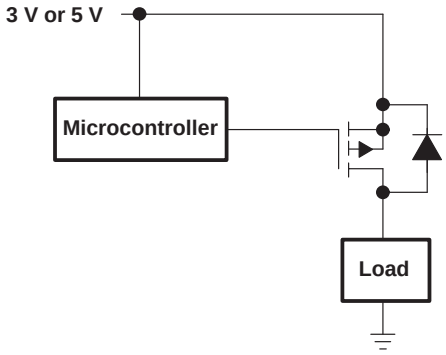


Figure 17. Notebook Load Management

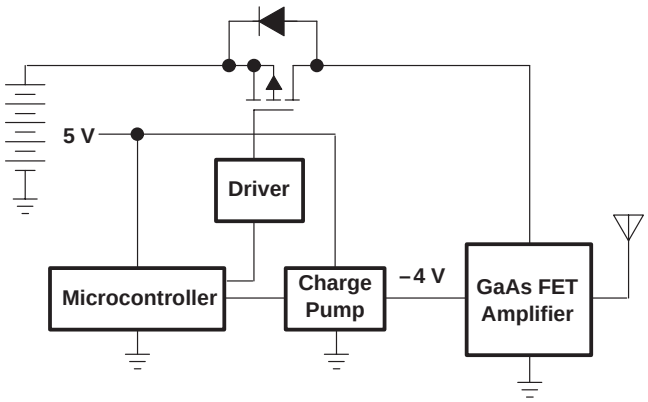


Figure 18. Cellular Phone Output Drive

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TPS1120D	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-	1120
TPS1120D.A	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	See TPS1120D	1120
TPS1120D.B	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	See TPS1120D	1120
TPS1120DR	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-	1120
TPS1120DR.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	See TPS1120DR	1120
TPS1120DR.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	See TPS1120DR	1120

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

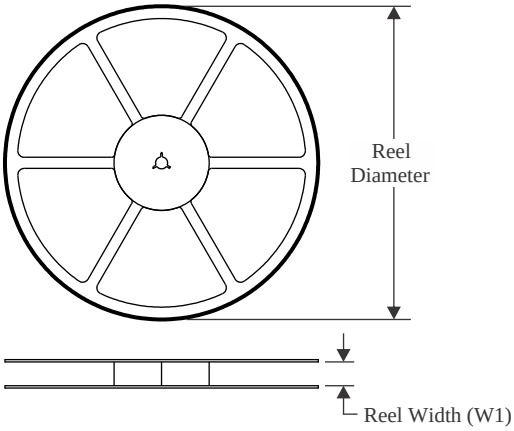
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

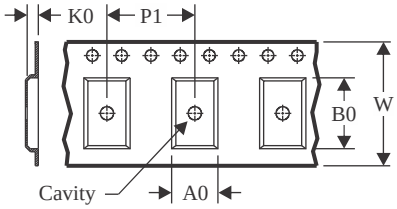
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

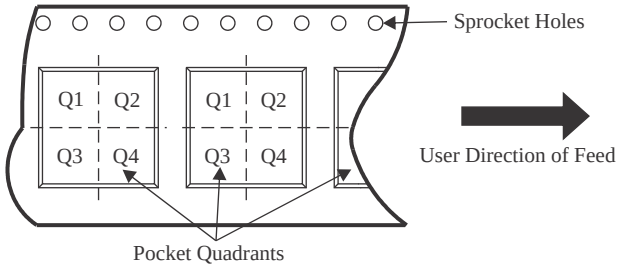


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

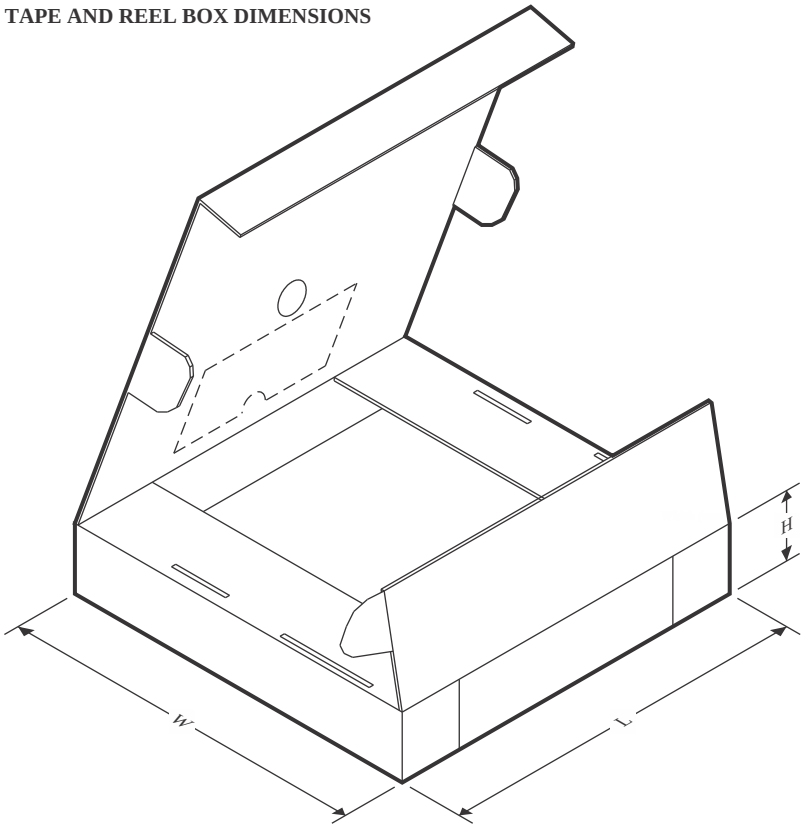
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS1120DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

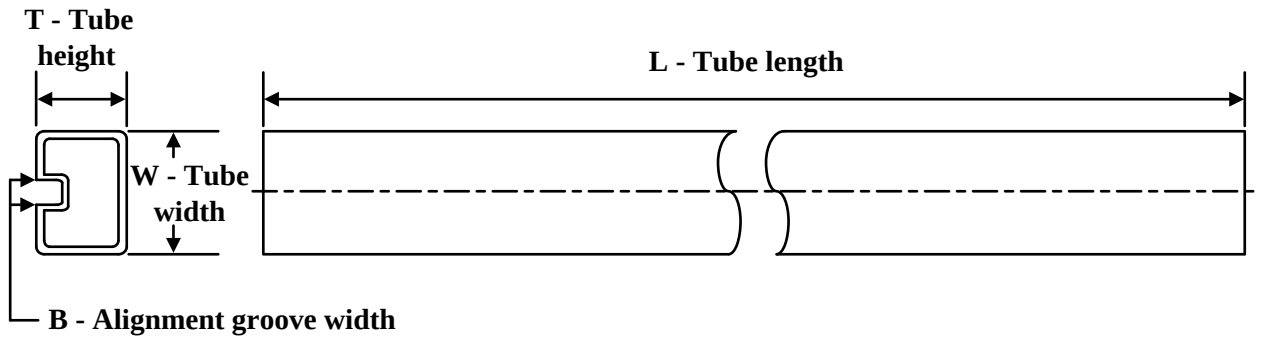
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS1120DR	SOIC	D	8	2500	350.0	350.0	43.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
TPS1120D	D	SOIC	8	75	505.46	6.76	3810	4
TPS1120D.A	D	SOIC	8	75	505.46	6.76	3810	4
TPS1120D.B	D	SOIC	8	75	505.46	6.76	3810	4

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