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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: [info@chipsmall.com](mailto:info@chipsmall.com) Web: [www.chipsmall.com](http://www.chipsmall.com)

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



# 2SC0435T2F1-17 and 2SC0435T2F1C-17

## Preliminary Datasheet

### Dual-Channel SCALE™-2+ IGBT and MOSFET Driver Core

#### Abstract

The SCALE™-2+ dual-driver core 2SC0435T2F1-17 (Connector pin length of 5.84mm; increased EMI capability; lead free) / 2SC0435T2F1C-17 (Coated version using ELPEGUARD SL 1307 FLZ/2 from Lackwerke Peters) combines unrivalled compactness with broad applicability. The driver is designed for universal applications requiring high reliability. The 2SC0435T2F1(C)-17 drives all usual high-power IGBT modules up to 1700V. The embedded paralleling capability allows easy inverter design covering higher power ratings. Multi-level topologies are also supported.

The 2SC0435T2F1(C)-17 is the most compact driver core in its power range with a footprint of only 57.2 x 51.6mm and an insertion height of max. 20mm. It allows even the most restricted insertion spaces to be efficiently used. Compared with conventional drivers, the highly integrated SCALE-2+ chipset allows about 85% of components to be dispensed with. This advantage is impressively reflected in increased reliability.

The 2SC0435T2F1(C)-17 combines a complete two-channel driver core with all components required for driving, such as an isolated DC/DC converter, short-circuit protection, Advanced Active Clamping as well as supply voltage monitoring. Each of the two output channels is electrically isolated from the primary side and the other secondary channel.

An output current of 35A and 4W drive power is available per channel, making the 2SC0435T2F1(C)-17 an ideal driver platform for universal usage in medium and high-power applications. The driver provides a gate voltage swing of +15V/-10V. The turn-on voltage is regulated to maintain a stable 15V regardless of the output power level.

Its outstanding EMC allows safe and reliable operation in even hard industrial applications.

#### Product Highlights

- ✓ Ultra-compact dual-channel driver
- ✓ Highly integrated SCALE-2+ chipset
- ✓ Gate current ±35A, 4W output power per channel
- ✓ +15V/-10V gate driving
- ✓ Blocking voltages up to 1700V
- ✓ Safe isolation to EN 50178
- ✓ Short delay and low jitter
- ✓ Interface for 3.3V ... 15V logic level
- ✓ Advanced Active Clamping
- ✓ UL recognition E321757 for UL508C (NMMS2/8)
- ✓ UL recognition E346491 for UL60950-1 (NWGQ2/8)
- ✓ Lead free

#### Applications

- ✓ General purpose drives
- ✓ Uninterruptible power supplies (UPS)
- ✓ Solar and wind power converters
- ✓ Auxiliary converters for traction
- ✓ Electro/hybrid drive vehicles
- ✓ Driving parallel-connected IGBTs
- ✓ Medical (MRT, CT, X-Ray)
- ✓ Laser technology

## Preliminary Data Sheet

### Safety Notice!

The data contained in this data sheet is intended exclusively for technically trained staff. Handling all high-voltage equipment involves risk to life. Strict compliance with the respective safety regulations is mandatory!

Any handling of electronic devices is subject to the general specifications for protecting electrostatic-sensitive devices according to international standard IEC 60747-1, Chapter IX or European standard EN 100015 (i.e. the workplace, tools, etc. must comply with these standards). Otherwise, this product may be damaged.

### Important Product Documentation

This data sheet contains only product-specific data. For a detailed description, must-read application notes and important information that apply to this product, please refer to "2SC0435T Description & Application Manual" on [www.power.com/igbt-driver/go/2SC0435T](http://www.power.com/igbt-driver/go/2SC0435T).

### Absolute Maximum Ratings

Parameter	Remarks	Min	Max	Unit
Supply voltage $V_{DC}$	VDC to GND	0	16	V
Supply voltage $V_{CC}$	VCC to GND	0	16	V
Logic input and output voltages	Primary side, to GND	-0.5	$V_{CC}+0.5$	V
SOx current	Failure condition, total current		20	mA
Gate peak current $I_{out}$	Note 1	-35	+35	A
External gate resistance	Turn-on and turn-off	0.5		$\Omega$
Average supply current $I_{DC}$	Notes 2, 3		1050	mA
Output power	Ambient temperature $<70^{\circ}\text{C}$ (Notes 4, 5)		6	W
	Ambient temperature $85^{\circ}\text{C}$ (Note 4)		4	W
Switching frequency $f$			100	kHz
Test voltage (50Hz/1min.)	Primary to secondary (Note 14)		5000	$V_{AC(eff)}$
	Secondary to secondary (Note 14)		4000	$V_{AC(eff)}$
$ dV/dt $	Rate of change of input to output voltage		50	kV/ $\mu\text{s}$
Operating voltage	Primary/secondary, secondary/secondary		1700	$V_{peak}$
Operating temperature	Note 5	-40	85	$^{\circ}\text{C}$
Storage temperature	Note 18	-40	50	$^{\circ}\text{C}$
Surface temperature	Only for 2SC0435T2F1C-17 (Note 17)		125	$^{\circ}\text{C}$



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**Recommended Operating Conditions**

Power Supply	Remarks	Min	Typ	Max	Unit
Supply voltage $V_{DC}$	VDC to GND, IGBT mode	14.5	15	15.5	V
Supply voltage $V_{CC}$	VCC to GND	14.5	15	15.5	V

**Electrical Characteristics (IGBT mode)**

All data refer to +25°C and  $V_{CC} = V_{DC} = 15V$  unless otherwise specified.

Power supply	Remarks	Min	Typ	Max	Unit
Supply current $I_{DC}$	Without load		32		mA
Supply current $I_{CC}$	$f = 0Hz$		22		mA
Supply current $I_{CC}$	$f = 100kHz$		32		mA
Coupling capacitance $C_{io}$	Primary to output, total		22		pF

Power Supply Monitoring	Remarks	Min	Typ	Max	Unit
Supply threshold $V_{CC}$	Primary side, clear fault	11.9	12.6	13.3	V
	Primary side, set fault (Note 11)	11.3	12.0	12.7	V
Monitoring hysteresis	Primary side, set/clear fault	0.35			V
Supply threshold $V_{ISOx}-V_{Ex}$	Secondary side, clear fault	12.1	12.6	13.1	V
	Secondary side, set fault (Note 12)	11.5	12.0	12.5	V
Monitoring hysteresis	Secondary side, set/clear fault	0.35			V
Supply threshold $V_{Ex}-V_{COMx}$	Secondary side, clear fault	5	5.15	5.3	V
	Secondary side, set fault (Note 12)	4.7	4.85	5	V
Monitoring hysteresis	Secondary side, set/clear fault	0.15			V

Logic Inputs and Outputs	Remarks	Min	Typ	Max	Unit
Input bias current	$V(INx) > 3V$		190		$\mu A$
Turn-on threshold	$V(INx)$		2.6		V
Turn-off threshold	$V(INx)$		1.3		V
SOx output voltage	Failure condition, $I(SOx) < 20mA$			0.7	V

Short-Circuit Protection	Remarks	Min	Typ	Max	Unit
Current through pin REFx	$R(REFx, VEx) < 70k\Omega$		150		$\mu A$
Minimum response time	Note 9		1.2		$\mu s$
Minimum blocking time	Note 10		9		$\mu s$

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Timing Characteristics	Remarks	Min	Typ	Max	Unit
Turn-on delay $t_{d(on)}$	Note 6		75		ns
Turn-off delay $t_{d(off)}$	Note 6		70		ns
Jitter of turn-on delay	Note 16		±3		ns
Jitter of turn-off delay	Note 16		±3		ns
Output rise time $t_{r(out)}$	Note 7		20		ns
Output fall time $t_{f(out)}$	Note 7		20		ns
Transmission delay of fault state	Note 13		400		ns
Electrical Isolation	Remarks	Min	Typ	Max	Unit
Test voltage (50Hz/1s)	Primary to secondary side (Note 14)	5000	5050	5100	$V_{eff}$
	Secondary to secondary side (Note 14)	4000	4050	4100	$V_{eff}$
Partial discharge extinction volt.	Primary to secondary side (Note 15)	1768			$V_{peak}$
	Secondary to secondary side (Note 15)	1700			$V_{peak}$
Creepage distance	Primary to secondary side	15.7			mm
	Secondary to secondary side	12			mm
Clearance distance	Primary to secondary side	15.7			mm
	Secondary to secondary side	7.3			mm
Output	Remarks	Min	Typ	Max	Unit
Blocking capacitance	VISOx to VEx (Note 8)		9.4		μF
	VEx to COMx (Note 8)		9.4		μF

## Output voltage swing

The output voltage swing consists of two distinct segments. First, there is the turn-on voltage  $V_{GHx}$  between pins GHx and VEx.  $V_{GHx}$  is regulated and maintained at a constant level for all output power values and frequencies.

The second segment of the output voltage swing is the turn-off voltage  $V_{GLx}$ .  $V_{GLx}$  is measured between pins GLx and VEx. It is a negative voltage. It changes with the output power to accommodate the inevitable voltage drop across the internal DC/DC converter.

Output Voltage	Remarks	Min	Typ	Max	Unit
Turn-on voltage, $V_{GHx}$	Any load condition		15.0		V
Turn-off voltage, $V_{GLx}$	No load		-10.1		V
Turn-off voltage, $V_{GLx}$	1W output power		-9.8		V
Turn-off voltage, $V_{GLx}$	4W output power		-9.5		V
Turn-off voltage, $V_{GLx}$	6W output power		-9.3		V

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### Footnotes to the Key Data

- 1) The maximum peak gate current refers to the highest current level occurring during the product lifetime. It is an absolute value and does also apply for short pulses.
- 2) The average supply input current is limited for thermal reasons. Higher values than specified by the absolute maximum rating are permissible (e.g. during power supply start up) if the average remains below the given value, provided the average is taken over a time period which is shorter than the thermal time constants of the driver in the application.
- 3) There is no means of actively controlling or limiting the input current in the driver. In the case of start-up with very high blocking capacitor values, or in case of short circuit at the output, the supply input current has to be limited externally.
- 4) The maximum output power must not be exceeded at any time during operation. The absolute maximum rating must also be observed for time periods shorter than the thermal time constants of the driver in the application.
- 5) An extended output power range is specified in the output power section for maximum ambient temperatures of 70°C. In that case, the absolute maximum rating for the operating temperature changes to (-40°C - 70°C) and the absolute maximum output power rating changes to 6W.
- 6) The delay time is measured between 50% of the input signal and 10% voltage swing of the corresponding output. The delay time is independent of the output loading.
- 7) Output rise and fall times are measured between 10% and 90% of the nominal output swing with an output load of 4.7Ω and 270nF. The values are given for the driver side of the gate resistors. The time constant of the output load in conjunction with the present gate resistors leads to an additional delay at the load side of the gate resistors.
- 8) External blocking capacitors are to be placed between VISOx and VEx as well as VEx and COMx for gate charges exceeding 3μC. Ceramic capacitors are recommended. A minimum external blocking capacitance of 3μF is recommended for every 1μC of gate charge beyond 3μC. Insufficient external blocking can lead to reduced driver efficiency and thus to thermal overload.
- 9) The minimum response time given is valid for the circuit given in the description and application manual (Fig. 7) with the values of table 1 ( $C_{ax} = 0pF$ ,  $R_{thx} = 43k\Omega$ ).
- 10) The blocking time sets a minimum time span between the end of any fault state and the start of normal operation (remove fault from pin SOx). The value of the blocking time can be adjusted at pin TB. The specified blocking time is valid if TB is connected to GND.
- 11) Undervoltage monitoring of the primary-side supply voltage (VCC to GND). If the voltage drops below this limit, a fault is transmitted to both SOx outputs and the power semiconductors are switched off.
- 12) Undervoltage monitoring of the secondary-side supply voltage (VISOx to VEx and VEx to COMx which correspond with the approximate turn-on and turn-off gate-emitter voltages). If the corresponding voltage drops below this limit, the IGBT is switched off and a fault is transmitted to the corresponding SOx output.
- 13) Transmission delay of fault state from the secondary side to the corresponding primary status output.
- 14) HiPot testing (= dielectric testing) must generally be restricted to suitable components. This gate driver is suited for HiPot testing. Nevertheless, it is strongly recommended to limit the testing time to 1s slots as stipulated by EN 50178. Excessive HiPot testing at voltages much higher than 1200V<sub>AC(eff)</sub> may lead to insulation degradation. No degradation has been observed over 1min. testing at 5000V<sub>AC(eff)</sub>. Every production sample shipped to customers has undergone 100% testing at the given value for 1s.
- 15) Partial discharge measurement is performed in accordance with IEC 60270 and isolation coordination specified in EN 50178. The partial discharge extinction voltage between primary and either secondary side is coordinated for safe isolation to EN 50178.
- 16) Jitter measurements are performed with input signals INx switching between 0V and 5V referred to GND, with a corresponding rise time and fall time of 15ns.
- 17) The component surface temperature, which may strongly vary depending on the operating condition, must be limited to the given value for coated driver versions to ensure long-term reliability of the coating material.

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- 18) The storage temperature inside the original package (1) or in case the coating material of coated products may touch external parts (2) must be limited to the given value. Otherwise, it is limited to 90°C.

### RoHS Statement

On the basis of Annexes II and III of European Directive 2011/65/EC of 08 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS), we hereby state that the products described in this datasheet do not contain lead (Pb), mercury (Hg), hexavalent chromium (Cr VI), cadmium (Cd), polibrometo of biphenyl (PBB) or polibrometo diphenyl ether (PBDE) in concentrations exceeding the restrictions set forth in Annex II of 2011/65/EC with due consideration of the applicable exemptions as listed in Annex III of 2011/65/EC.

### Legal Disclaimer

The statements, technical information and recommendations contained herein are believed to be accurate as of the date hereof. All parameters, numbers, values and other technical data included in the technical information were calculated and determined to our best knowledge in accordance with the relevant technical norms (if any). They may base on assumptions or operational conditions that do not necessarily apply in general. We exclude any representation or warranty, express or implied, in relation to the accuracy or completeness of the statements, technical information and recommendations contained herein. No responsibility is accepted for the accuracy or sufficiency of any of the statements, technical information, recommendations or opinions communicated and any liability for any direct, indirect or consequential loss or damage suffered by any person arising therefrom is expressly disclaimed.

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## Preliminary Data Sheet

### Ordering Information

Our international terms and conditions of sale apply.

Type Designation	Description
2SC0435T2F1-17	Dual-channel SCALE-2+ driver core (Connector pin length of 5.84mm, increased EMI capability, lead free)
2SC0435T2F1C-17	Dual-channel SCALE-2+ driver core (Connector pin length of 5.84mm, increased EMI capability, lead free, conformal coating)

Product home page: [www.power.com/igbt-driver/go/2SC0435T](http://www.power.com/igbt-driver/go/2SC0435T)

Refer to [www.power.com/igbt-driver/go/nomenclature](http://www.power.com/igbt-driver/go/nomenclature) for information on driver nomenclature

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### Information about Other Products

**For other drivers, product documentation, and application support**

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Please click: [www.power.com](http://www.power.com)

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## Preliminary Data Sheet

**Power Integrations Sales Offices**
**WORLD HEADQUARTERS**

5245 Hellyer Avenue  
San Jose, CA 95138 USA  
Tel: +1-408-414-9200  
Fax: +1-408-414-9765  
Email: [usasales@power.com](mailto:usasales@power.com)

**AMERICAS WEST**

5245 Hellyer Avenue  
San Jose, CA 95138 USA  
Tel: +1-408-414-8778  
Fax: +1-408-414-3760  
Email: [usasales@power.com](mailto:usasales@power.com)

**GERMANY** (AC-DC/LED Sales)

Lindwurmstrasse 114  
80337 München, Germany  
Tel: +49-89-5527-39100  
Fax: +49-89-1228-5374  
Email: [eurosales@power.com](mailto:eurosales@power.com)

**INDIA** (Mumbai)

Unit: 106-107, Sagar Tech Plaza-B  
Sakinaka, Andheri Kurla Road  
Mumbai, Maharashtra 400072 India  
Tel 1: +91-22-4003-3700  
Tel 2: +91-22-4003-3600  
Email: [indiasales@power.com](mailto:indiasales@power.com)

**JAPAN**

Kosei Dai-3 Bldg.  
2-12-11, Shin-Yokohama, Kohoku-ku  
Yokohama-shi, Kanagawa  
Japan 222-0033  
Tel: +81-45-471-1021  
Fax: +81-45-471-3717  
Email: [japansales@power.com](mailto:japansales@power.com)

**TAIWAN**

5F, No. 318, Nei Hu Rd., Sec. 1  
Nei Hu Dist.  
Taipei, 114 Taiwan  
Tel: +886-2-2659-4570  
Fax: +886-2-2659-4550  
Email: [taiwansales@power.com](mailto:taiwansales@power.com)

**AMERICAS EAST**

7360 McGinnis Ferry Road  
Suite 225  
Suwannee, GA 30024 USA  
Tel: +1-678-957-0724  
Fax: +1-678-957-0784  
Email: [usasales@power.com](mailto:usasales@power.com)

**CHINA** (Shanghai)

Room 2410, Charity Plaza  
No. 88 North Caoxi Road  
Shanghai, 200030 China  
Tel: +86-21-6354-6323  
Fax: +86-21-6354-6325  
Email: [chinasales@power.com](mailto:chinasales@power.com)

**GERMANY** (Gate Driver Sales)

HellwegForum 1  
59469 Ense, Germany  
Tel: +49-2938-64-39990  
Email: [igbt-driver.sales@power.com](mailto:igbt-driver.sales@power.com)

**INDIA** (New Dehli)

#45, Top Floor  
Okhla Industrial Area, Phase - III  
New Dehli, 110020 India  
Tel 1: +91-11-4055-2351  
Tel 2: +91-11-4055-2353  
Email: [indiasales@power.com](mailto:indiasales@power.com)

**KOREA**

RM602, 6FL, 22  
Teheran-ro 87-gil, Gangnam-gu  
Seoul, 06164 Korea  
Tel: +82-2-2016-6610  
Fax: +82-2-2016-6630  
Email: [koreasales@power.com](mailto:koreasales@power.com)

**UNITED KINGDOM**

Bulding 5, Suite 21  
The Westbrook Centre  
Milton Road  
Cambridge, CB4 1YG United Kingdom  
Tel: +44-7823-557-484  
Email: [eurosales@power.com](mailto:eurosales@power.com)

**AMERICAS CENTRAL**

333 Sheridan Road  
Winnetka, IL 60093 USA  
Tel: +1-847-721-6293  
Email: [usasales@power.com](mailto:usasales@power.com)

**CHINA** (Shenzhen)

17/F, Hivac Building, No 2  
Keji South 8th Road, Nanshan District  
Shenzhen, 518057 China  
Tel: +86-755-8672-8689  
Fax: +86-755-8672-8690  
Email: [chinasales@power.com](mailto:chinasales@power.com)

**INDIA** (Bangalore)

#1, 14th Main Road  
Vasanthangar  
Bangalore, 560052 India  
Tel 1: +91-80-4113-8020  
Tel 2: +91-80-4113-8028  
Fax: +91-80-4113-8023  
Email: [indiasales@power.com](mailto:indiasales@power.com)

**ITALY**

Via Milanese 20  
20099 Sesto San Giovanni (MI), Italy  
Tel: +39-02-4550-8708  
Email: [eurosales@power.com](mailto:eurosales@power.com)

**SINGAPORE**

51 Newton Road  
#19-01/05 Goldhill Plaza  
Singapore, 308900  
Tel 1: +65-6358-2160  
Tel 2: +65-6358-4480  
Fax: +65-6358-2015  
Email: [singaporesales@power.com](mailto:singaporesales@power.com)