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FLOETH ELECTRONIC

issued: 08/06

HVxHHSC-30A(automotive) & HVxHHSC-30I(industrial)

IGBT DRIVER MODULES

NEW OSA / SHORT OUTPUT FOR SMOOTH TURN OFF ****

In Failure Mode the standard TOTEM POLE becomes disabled and a 2nd. LOW Transistor takes over and cleans the Gate charge via an RSC Gate Resistor with 20-70 ohms

******** NEW: 10µs or other min. Gate Pulse Width *******

min. Pulse Width from 0/ and 1µs to seconds possible

IGBT Driver Module Application Note

FEATURES

- Application NPT-SPT & Trench IGBT's 1200 to 6500V
- OSA failure Gate Totem Pole disabled and SOFT OFF active
- Very limited-controlled Vce voltage overshoots
- min. Gate Pulse Width 10µs whatever the microcontroller send below that number. Less stress for the Diodes and less V-overshoot
- Suitable Existing Interface Cards available
- Protects IGBT from Short Circuit Failure I &II
- High Reliability
- Gate Current to +30A/-30A and very LOW custom set
- Electrical Isolation min. 10kV AC rms
- Partial Discharge Free From 2300 to 6000V AC rms
- Supply Voltage Monitoring, UVLO
- Switching Frequency DC to >100kHz
- Limitation Input Current 900mA at 15V IN
- Duty Cycle 0 to 100%
- Built-in Isolated DC/DC Power Supply

KEY PARAMETERS

Drive Voltage	**±15V**
Drive Power	**±6W total 12W**
Gate Drive Current	**+30A/-30A peaks** (1R0)
REF. Voltage	**30V**

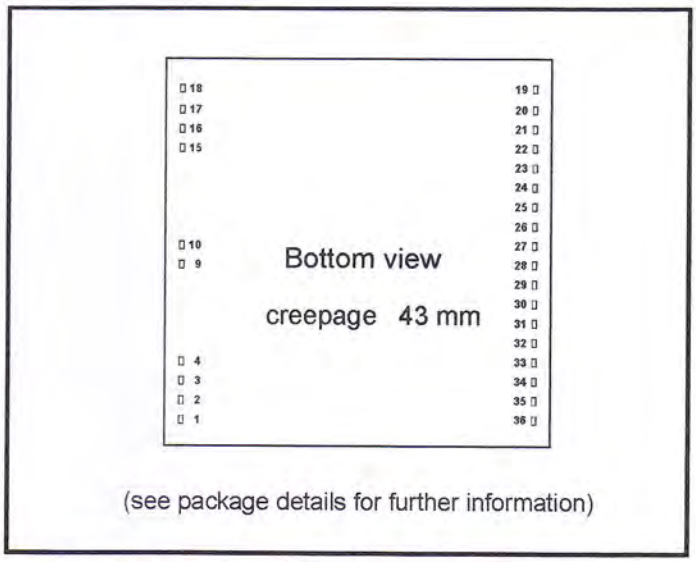

Fig. 1 Electrical connections - (not to scale)

APPLICATIONS

- Industrial Drives
- Multi Level Converters
- Railway Traction Drives and Auxilliaries
- Power Supplies
- Wind Turbines

This application note features an IGBT Driver Solution designed and manufactured by Floeth Electronic is a compact single channel intelligent gate drive module which in combination with the appropriate interface board can be used to drive high power IGBT modules from major manufacturers. The module incorporates a DC/DC power supply and features functional options selectable via jumpers on the Interface Card.

Complete driver solutions consisting of these modules mounted on suitable Interface-CORE cards are available. please contact Floeth Electronic via floeth-electronic@t-online.de

The information presented herein is provided in good faith but it is the users responsibility to determine the performance suitability of this drive solution in any actual application

* 15W; 20W upon request

** measured with Rg ON/OFF = 1Ω info 470nF polypropelene cap.

ORDERING INFORMATION

Order As: **Industrial Version**

HV2 HHSC - 30I
2300V AC rms partial discharge free

HV4 HHSC - 30I
4000V AC rms partial discharge free

HV5 HHSC - 30I
5000V AC rms partial discharge free

Hv6 HHSC - 30I
6000V AC rms partial discharge free

Note: When ordering, please use the complete part number.

*** Can be delivered with greater creepage upon demand. ***

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HVxHHSC-30 I/A Series Application Note

Special Features: - Gate Pulse Width min. 10µs
- Extra Gate Output for smooth OSA - TURN OFF

ABSOLUTE MAXIMUM RATINGS

Stresses above those listed under 'Absolute Maximum Ratings' may cause permanent damage to the device. In extreme conditions, as with all semiconductors, this may include potentially hazardous rupture of the package.Appropriate safety precautions should always be followed. Exposure to Absolute Maximum Ratings may affect device reliabillity.

T_{case} = +25°C unless stated otherwise

Symbol	Parameter	Test Conditions	Min.	Max.	Units
V_{DC}	Supply voltage	V_{DC} to GND	0	16	V
I_{OUT}	Gate peak output current	-	-	≤30	A
V_{logic}	Internal logic supply - linear regulated	-	-	5	V
I_{DC}	Average supply current	No load	-	150	mA
$I_{DC(max.)}$	Maximum supply current	-	-	900	mA
P_{OUT}	Output power DC/DC converter	-	1	12	W
f	Swiching frequency	Depending on load characteristics	-	100	kHz
$V_{ISOL.}$	Isolation voltage	AC RMS 1 min.	-	10	$kV_{AC(RMS)}$
V_{REF}	Internal reference voltage	Line regulated	-	30	V
T_{amb}	Ambient temperature range - Industrial - HVxHHSC-30I	-	-40	+71	°C
	Ambient temperature range - Automotive - HVxHHSC-30A	-	-55	+85	°C
T_{stg}	Storage temperature range	-	-55	+90	°C

ELECTRICAL CHARACTERISTICS - POWER SUPPLY

T_{case} = +25°C and V_{DC} = 15V unless stated otherwise

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
V_{DC}	Nominal supply voltage	V_{DC} to GND	14.25	15	15.75	V
UVLO	Undervoltage lockout (driver input voltage)	Internally generated,	-	U 12,1 D 11,8	-	V **
I_{DC}	Supply current	Zero load	-	-	150	mA
P_{MOD}	Power consumption of driver module	15V supply, zero load	-	1.5	-	W

** They driver OUTPUT VOLTAGE is always higher than the input voltage depending on load characteristics.
U= up sloop UVLO circuit activates drive during power on
D= down sloop UVLO circuit deactivates drive during power off

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ELECTRICAL CHARACTERISTICS - LOGIC INPUT

T_{case} = +25°C and V_{DC} = 15V unless stated otherwise

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
V_{INH}	Input H - level voltage	-	3,8	-	15	V
V_{INL}	Input L - level voltage	-	-0,3	-	0.8	V

ELECTRICAL CHARACTERISTICS - ELECTRICAL ISOLATION

T_{case} = +25°C and V_{DC} = 15V unless stated otherwise * = stay for either I or A

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
V_{TEST}	Test voltage - Primary to output	50Hz / 1 min.	-	-	10	$kV_{AC(RMS)}$
V_{ISOL}	Isolation voltage - HV2HHSC-30x*	-	-	-	2.3	$kV_{AC(RMS)}$
V_{ISOL}	Isolation voltage - HV4HHSC-30x*	-	-	-	4	$kV_{AC(RMS)}$
V_{ISOL}	Isolation voltage - HV5HHSC-30x*	-	-	-	5	$kV_{AC(RMS)}$
V_{ISOL}	Isolation voltage - HV6HHSC-30x*	-	-	-	6	$kV_{AC(RMS)}$
-	Creepage distance - primary to output		-	-	43	mm

ELECTRICAL CHARACTERISTICS - POWER SUPPLY

T_{case} = +25°C and V_{DC} = 15V unless stated otherwise

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
$t_{d(out)}$	Tum-on delay time	Refer to Figs. 9 and 10	-	550	-	ns
$t_{d(out)}$	Tum-off delay time	Refer to Figs. 9 and 10	-	550	-	ns
$t_{r(out)}$	Output current rise time	Refer to Figs. 9 and 10	-	100	-	ns

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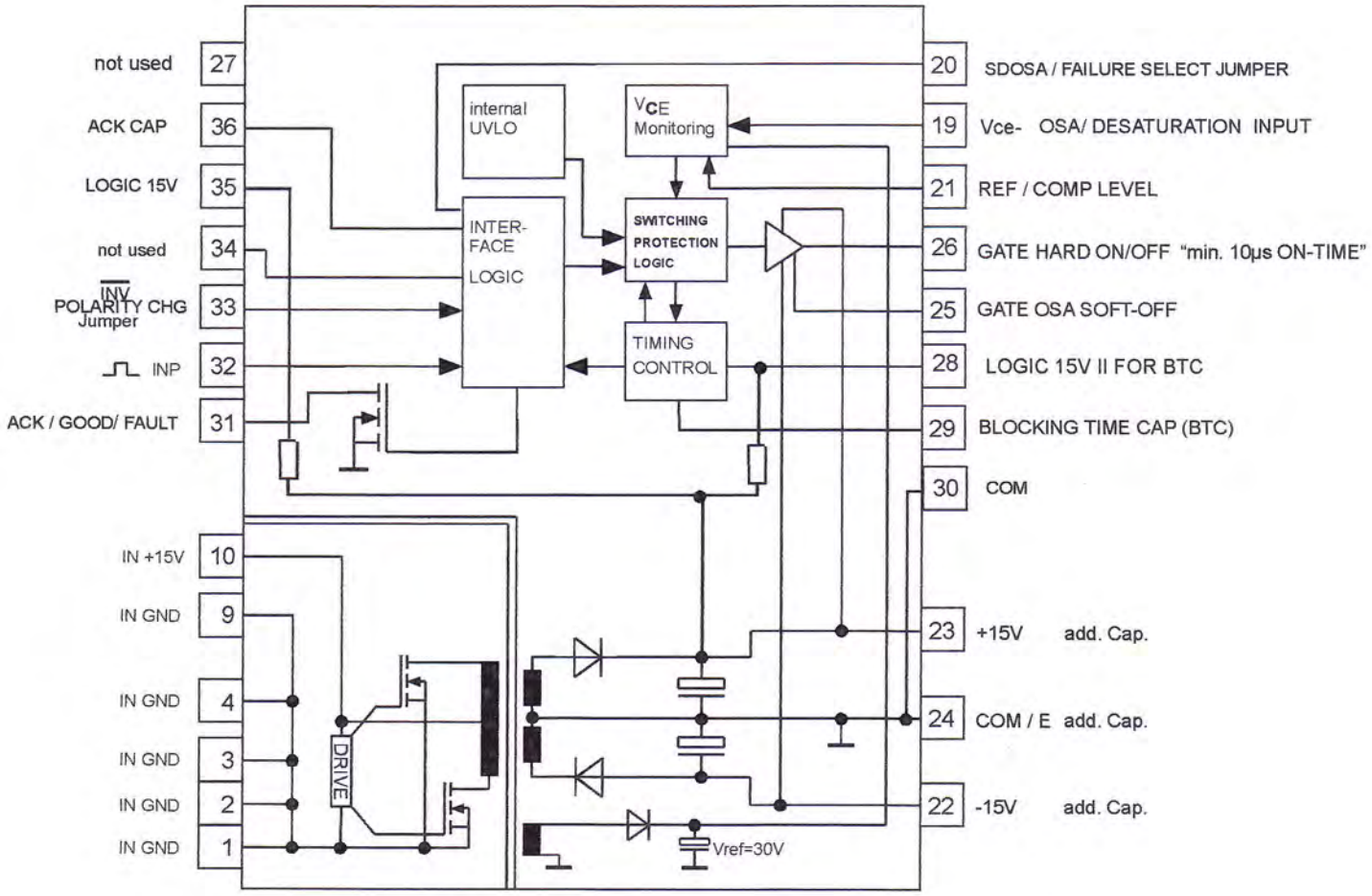
Special Features: - Gate Pulse Width min. 10µs
- Extra Gate Output for smooth OSA-TURN OFF

BLOCK DIAGRAM



Remaining fitted pins not labelled are not connected

Fig. 2 Module block diagram

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- Extra Gate Output for smooth OSA-TURN OFF

PIN CONNECTIONS

Pin No.	Description	Note
1	INPUT GND	
2	INPUT GND	
3	INPUT GND	
4	INPUT GND	
5 to 8	NOT CONNECTED	
9	INPUT GND	
10	INPUT +15V ±5%	
11 to 18	NOT CONNECTED	
19	V_{CE} /DES or OSA PIN	Monitoring Collector of power switch via fast HV-blocking diode, resistor and Sense Capacitor to COM
20	SDOSA /SELECT	Termination Inhibit see page 10 for outside connection
21	REF / COMPARATOR Voltage Pin	Level to be adjusted to suit actual IGBT. VCE / DES in turn ON mode, to be set by appropriate Zener diode or resistor. Intenal Ref. Suppy-Voltage is 30V which allows VCE / DES to be monitored up to 28v approx.
22	- 15V Supply voltage	Decoupling/ charge capacitor required.
23	+ 15V Supply voltage	Decoupling/ charge capacitor required.
24	COM / E	Secondary side common / Power switch emitter connection point.
25	GATE OSA-FAILURE SOFT OFF	Connect via 20-70 ohms Gate Resistor for very soft turn off
26	Gate Output HARD TURN ON/OFF	min. 10µs ON-TIME whatever Input PW is!!! Connect via Gate Resistor
27	not used	
28	LOGIC 15VII FOR BTC	CHARGE POWER FOR BLOCKING TIME CAPACITOR
29	BLOCKING TIME CAPACITOR (BTC)	Value determines time $\overline{\text{FAULT}}$ signal remains Low after removal of fault condition.
30	COM	GND for all small signal and logic connection
31	ACK / GOOD /FAULT OUTPUT	STATUS OUTPUT (SO) TRANSMITTER
32	SIGNAL INPUT ⎍⎍	Connect to FOL - Receiver requires 5V signals
33	$\overline{\text{INV}}$ POALARITY CHANGE	INPUT / OUTPUT REVERSAL
34	not used	
35	LOGIC 15V FOR ACK CAP	CHARGE POWER TO SET TIME FOR ACKNOWLEDGEMENT
36	ACK CAPACITOR	FOR PULSE WIDTH SET

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HVxHHSC-30 I/A Series Application Note

INTRODUCTION

HVxHHSC-30A series offers a complete solution for driving and protecting IGBT module and only a few additional components are required in the control circuit and in the power section.

Hvx HHSC-30I/A is suitable for high frequency switching up to 100kHz.

This module may also be used in conjunction with Floeth Electronic Cards
HVxHHSC - A - CORE BOARD
and some custom Interface Card incl. for 3 IGBT's

RELIABLE OPERATION

A gate voltage between ±14V to ±16V low noise ensures reliable operation of IGBT modules. High immunity is achieved with the negative gate voltage, and a number of IGBT's may be connected in parallel without problems from parasitics.

The module incorporates short circuit protection for the IGBT, supply monitoring, status acknowledgement, and an electrically isolated supply for the drive electronics.

SHORT CIRCUIT PROTECTION I & II

I switch into a short
II short appears during turn on

One of the fundamental functions of the driver module is to ensure reliable protection of the controlled IGBT against short circuit and over current. The current measurement is based on colector-emitter voltage of the IGBT in the on-state. Once the predetermined threshold has been exceeded the IGBT is fast turned off and remains "blocked" in normal mode for a minimum predetermined time (blocking time) Once the period elapsed the IGBT is released and may switch.

This is a simple and reliable method of protection for the IGBT removing the requirement for additional components.

PIN DESCRIPTIONS

Pins 1, 2, 3, 4, 9 and 10 GND and V_{CE}

The nominal feed on the power supply pins is + 15V ±5% For reliable operation of the integrated DC/DC converter a low impedance, high ripple current rated electrolytic capacitor must be positioned in the immediate vicinity of Pins 9 and 10, The capacitance of this component should typically be the same value as the capacitor connected to Pin 23. The DC/DC converter current consumption is dictated by the number of IGBTs in parallel being driven, their gate charge energy and by the switching frequency.

Pins 19 - V_{CE} /DES Monitor Input

This is used to monitor the voltage drop across the collector-emitter of the controlled IGBT at turn-on in order to detect a short circuit condition. **Note: Do not connect directly to the auxiliary collector of the IGBT.** To block the high collector voltage that is present when the IGBT is turned off, a high voltage diode (or several diodes) must be connected in series. The voltage rating of these diodes must exceed the maximum voltage seen at the IGBT collector in transient turn-off conditions.

A current source in the driver module ensures that current flows through the blocking diodes (D1to D3), the attenuation resistor (Rs) and the IGBT at turn-on. The function of Rs is to attenuate spikes caused by reverse recovery of diodes D1 to D3. Typically Rs has a value of 68Ω.

When the IGBT is turned on, the potential present at the measurement input of V_{CE} /DES corresponds to the forward voltage of the IGBT plus the forward voltage of the diodes and the voltage drop across RS.
The integrated voltage/current source and the external capacitor C sense produce a measurement delay after the IGBT has switched on. The delay is known as the "response time" and C sense must be selected to provide a delay greater than the turn-on time (or switch through time) of the IGBT.

When C sense and Vref are well selected the IGBT works fine and has a safe time window for short I and II.

The BAT 46 avoids that Pin 19 may travel negative
about 80pF has to be deducted from the goal capacitance
of formula below for sense cap value.

$$C\ sense\ (pF) \sim \frac{response\ time\ t(ns) - 600ns}{33ln\ ((29,886V/(30V - Vref\ at\ P21))} - 30$$

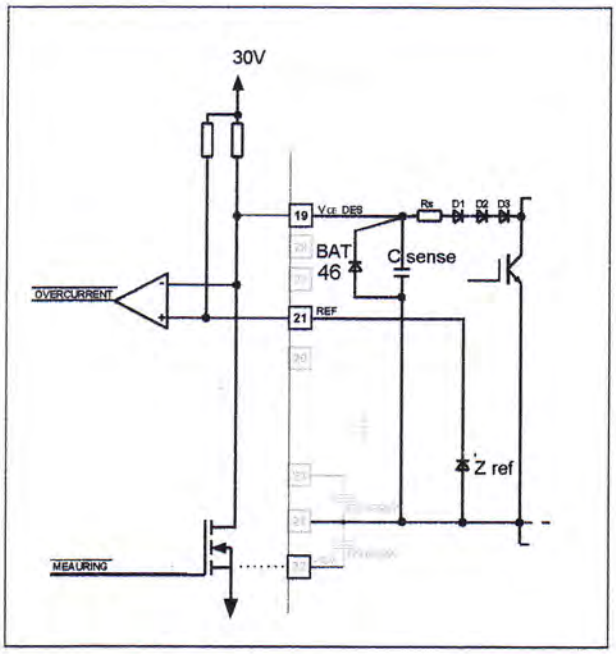

Fig. 3 V_{CE} monitoring

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Pin 20 - SDOSA

This pin will be conected to a Jumper if Jumper is open
Pin 20 see's 15V via a 10k pull up. Termination Inhibit!
In case of Failure driver wont terminate just sent a
Failure signal to the Processor (Tranmitter Light OFF).

Jumper closed, pulled to COM
Driver terminates on Failure and reports Failure

Pin 21 - Reference Voltage, REF

The external zener diode connected to this pin defines the voltage drop across the driven IGBT at which the desaturation detection function of the drive circuit is activated.

The protection function becomes active when the voltage at Pin 19 (V_{CE} / DES Monitor) is higher than that at REF.

The reference potential is the emitter of the IGBT. The reference zener diode must be positioned as close to the driver moduls as possible.

Pin 22 -15V

A low impedance, high ripple current rated electrolytic capacitor is connected at Pin 22. This de-couples the DC/DC converter on the secondary side. The capacitor must supply the pulses of current that discharge the IGBT gate capacitance. The capacitor is connected between Pin 22 and Pin 24 (COM). As the discharging currents for the gate are drawn mainly trom the capacitor it is imperative that it is positioned as near to the driver module as is physically possible. The recommended value for the capacitor is 470µF. Values significantly greater than this may prevent the DC/DC converter from starting at power - up.

If flying leads are used between the driver module and the IGBT emitter or drain terminals then their length should not exceed 100mm. The leads should run to each IGBT in twisted form,

Pin 23- +15V

A low impedance high ripple current rated electrolytic capacitor is connected at Pin 23. This de-couples the DC/DC converter on the secondary side. The capacitor must supply the pulses of current that charge the IGBT gate capacitance. The capacitor is connected between Pin 23 and Pin24(COM). As the charging currents for the gate are drawn mainly form the capacitor it is imperative that it is positioned as near to the driver module as is physically possible. The recommended value for the capacitor is 470µF. Values significantly greater than this may prevent the DC/DC converter from starting at power-up.

Pin 24 - Power Switch Emitter, COM

This pin should be connected directly to the IGBT emitter terminal (Or auxiliary emitter terminal where available) using as short a laed as possible. It is also used as the zero voltage reference point for reference voltage REF.

Pin 25 - Output Gate OSA - SOFT Turn OFF

SOFT- TURN OFF resistor values, 20-70 ohms

HOW it works:

In OSA Failure Gate HARD outputput Pin 26 will be dactivated and another LOW SIDE MOSFET takes over to the SOFT OUT Pin 25

Pin 26 - Output Gate HARD ON/OFF

Special Feature: min. 10µs Gate PW whatever microcontroller does release below 10µs.

This is the driver output for the IGBT gate. Depending on the module supply voltage tolerance, potential is about +/-15V.

The output stages of the HVxHHSC-30x series delivers a maximum possible gate charge current of +30A. The charging current can be limited by an external gate resistor. Remember that when the gate is driven with an alternating voltage arround zero, the potential difference across the gate capacitance is usually (depending operating frequency and therfore load) about 30V.

During IGBT turn-off the Miller effect may cause the gate voltage to rise and this can delay device turn-off. It is advisable to connect zener diodes (Z18V) immediately between the IGBT gate and emitter to clamp the gate voltage to a predetermined level. Z- Diodes to be min. 18V Diodes !!!.

The gate of the IGBT must be connected to Pin 26 by wire or interface Card junction..

Consider also the internal IGBT gate resistance while calculating the numbers for Rg's.

Internal Gate Resistances can vary from 0,2 to 0,6 ohms depending on products and different manufactureres design.

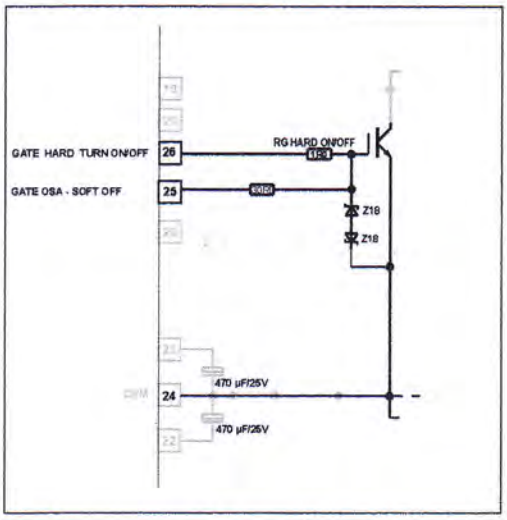

Fig. 4 Gate Drive

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Pin 27

Not used

Pin 28 - LOGIC 15VII

This Pin supplies 15V via an internal charge Resitor to supply the Blocking Capacitor (BTC)

Pin 29 - Blocking Time Capacitor

Once OSA or Desaturation is detected depending on Failure respond setting driver terminates or not.

But at least the Fibre Optic Transmitter Light will be shut OFF and a failure will be reported for the set Blocking time.

We insert standard 470nF

Pin 30 - COM

Ground for all small signal and logic connections. See Fig. 5.

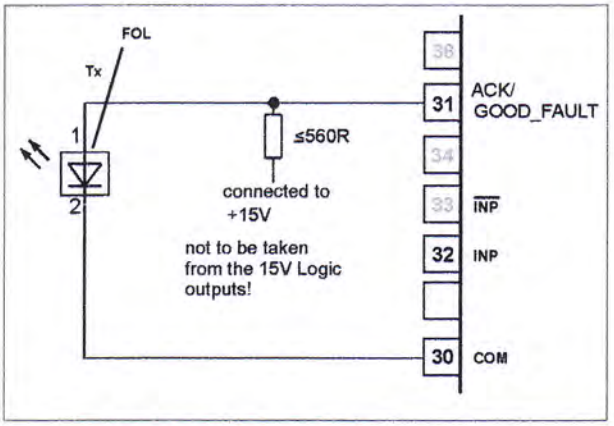

Fig. 5 Fibre optic transmitter wiring

Pin 31 - ACK / GOOD / FAILURE

Internal MOSFET pulls down by set frequency tact.
see Fig. 5

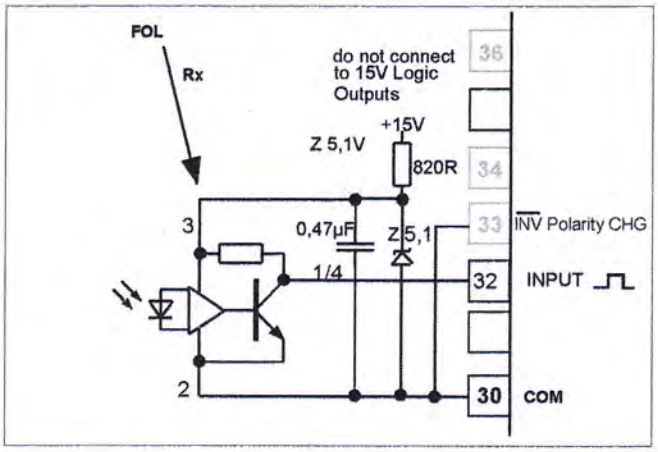

Fig. 6 Fibre optic receiver wiring

Pin 32 - INPUT Signal

The output signal of the FOL receiver is applied to this terminal. Recommended receiver/transmitter see page 10. The INPUT has a Schmitt trigger characteristic to provide improved signal-to-noise immunity. The logic sense of the INPUT terminal may be inverted by Pin 33 INV (INPUT / OUTPUT Reversal). With INV connected to COM a 5V signal at INPUT corresponds to "IGBT OFF", and a 0V signal to "IGBT ON". If INV is open, INPUT works in the opposite sense.

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Pin 33 - $\overline{\text{INV}}$ Polarity Change

The pin allows the sense of input signal INPUT to be inverted.
Input LOW (P 33 connected to COM) gate output Pin 25 is in antiphase to input.
Input HIGH (p 33 open) gate output is in phase to input signal

Pin 24 - not used

Pin 35 - LOGIC 15

provides 15V via a pull up resistor to charge ACK Capacitor.

Shall not be used for other purpose

If the SO pulse is low for longer than usual then the control electronics may assume that there is a problem with the FOL. **Incorrectly installed FOL connections may have catastrophic results.**

Pin 36 - ACK Capacitor

set's time for Acknowledgement Pulse width

POWER SECTION - CONFIGURATION

The driver module should be positioned as close as possible to the controlled IGBT with connection leads not more than 30 to 100mm in length, depending on the gate current and switching speed. The FOL cable lengths are not critical.

GATE RESISTOR - R_G-HARD ON/OFF

R_G determines the maximum gate current and protects the power switch and the driver against permanent damage. A low inductance metal band resistor is recommended.

For example, for type HVxHHS-30

R_G for a gate current of 30A = V_{gate} / I_{max} driver
= 30V / 30A = 1,0 Ohm min. **[3]**

Note that any internal gate resistance in the IGBT modules forms part of the charging circuit and must be taken into account when selecting the external gate resistor value.

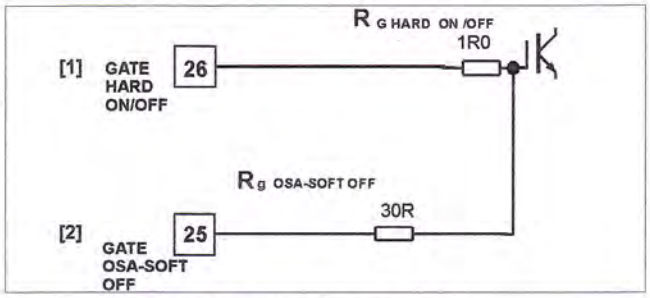

Fig. 7 Gate resistor networks

GATE RESISTOR-Rg HARD-SOFT-OFF
see description Pin 25 & 26

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REFERENCE VOLTAGE - Z_{REF}

The V_{CE} voltage at which overcurrent / short circuit condition is detected to be set by the Zener diode connected to Pin 21. Alternatively, a 47KΩ potentiometer may be used to allow easy adjustment.

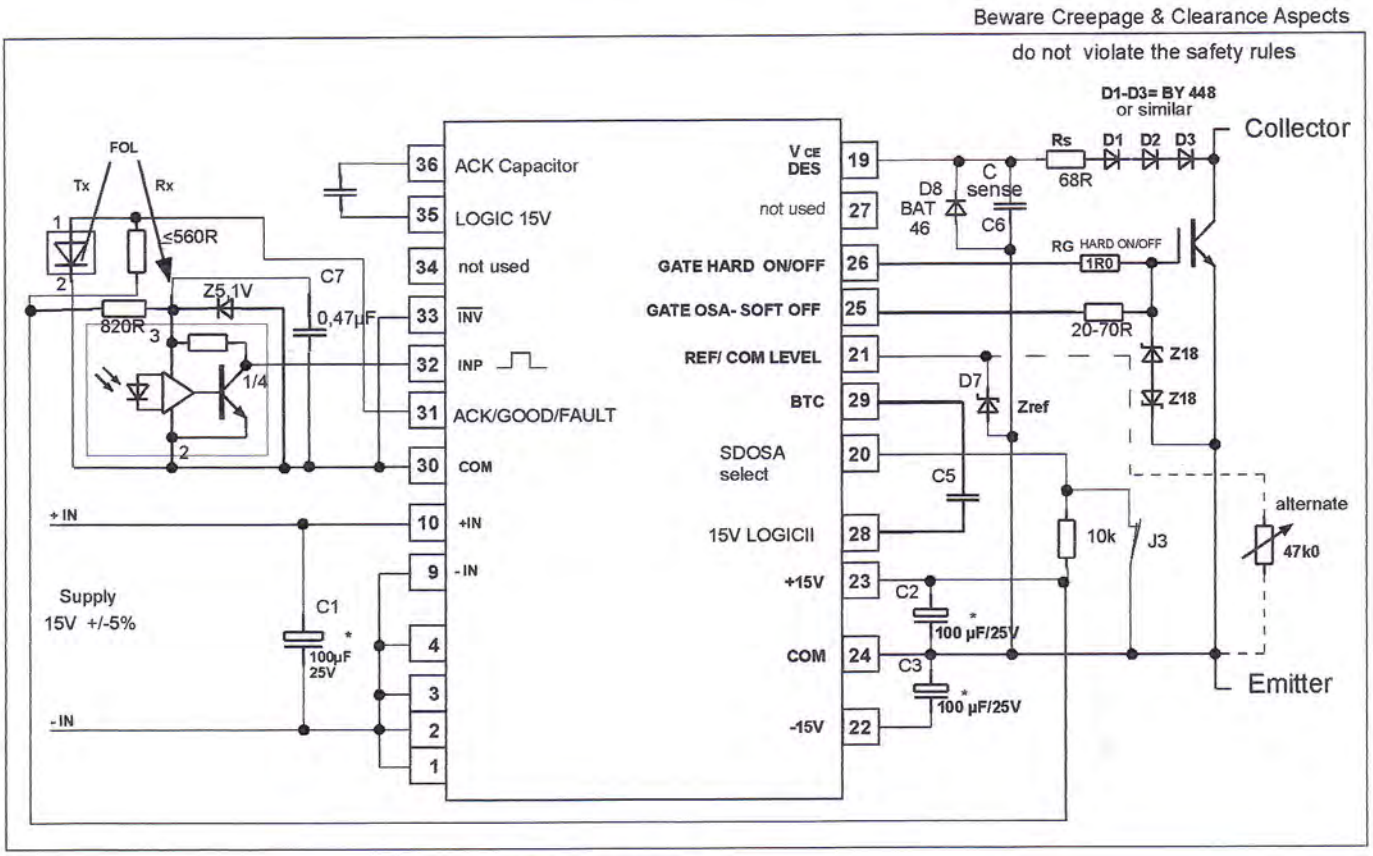

Fig. 8 Example driver circuit

* buffer caps must have reasonable permissble ripple current sturdiness therefore we recommend Sanyo OSCON 100µF/20V

if tantalums are used there nominal voltage shall be 35V!

FIBRE OPTIC LINK - RECOMMENDATION

HP / Agilent Transmitter: HFBR-1524

HP / Agilent Receiver: HFBR- 2524

see www.floeth-electronic.com IGBT section & Interface - cards

For Applications where big single IGBT's and single Driver be used due to MW-Power for thermal or Safety Reasons (Creepage & Clearances) we could offer an INTERFACE to drive the two single HALF-BRIDGE modules with to set INTERLOCK (dead time).

We can offer a Fibre Optic Link (FOL) Interfacing Solution to serve two single Modules in HB-mode.

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TIMING PATTERN I Input /Gate & other Traces

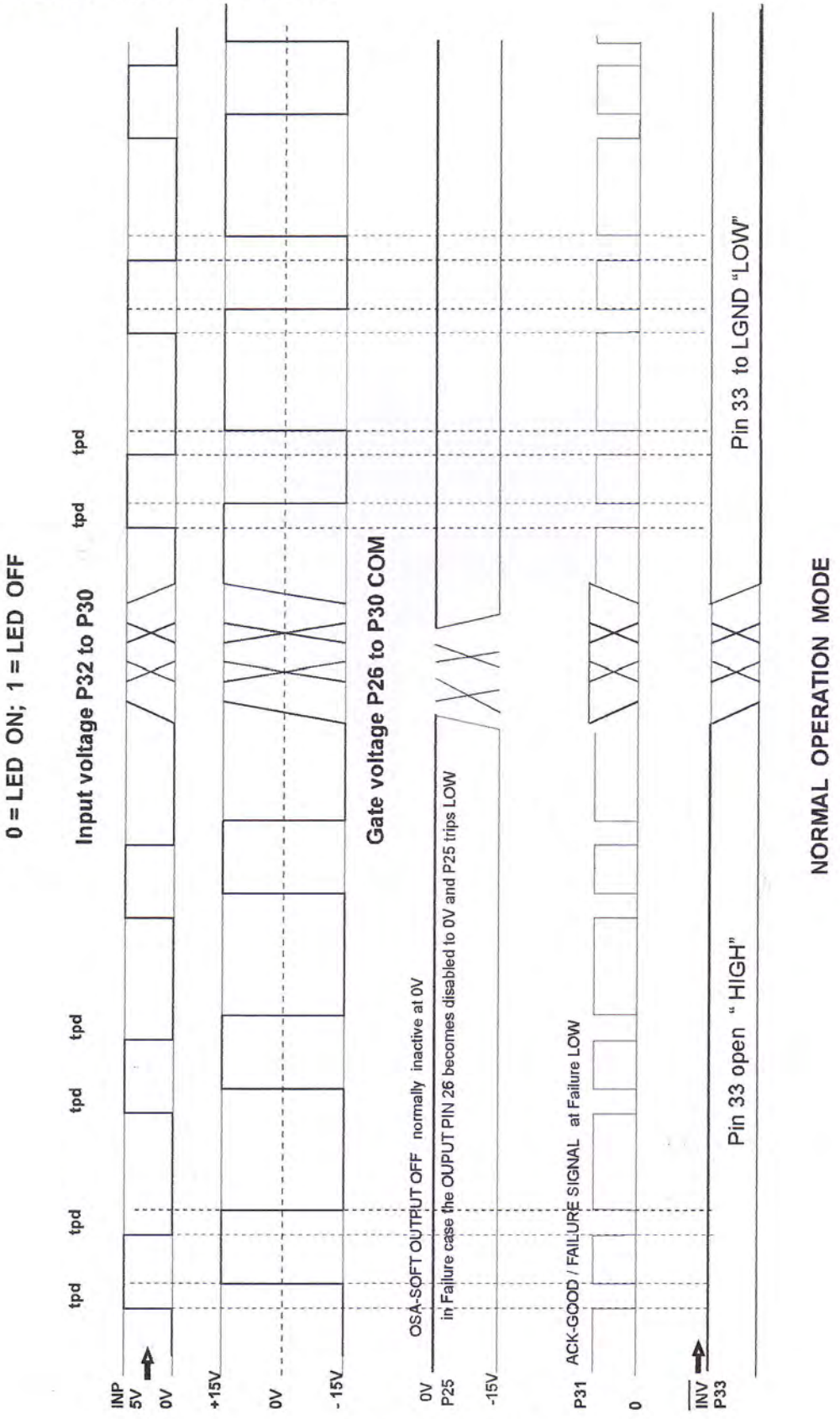

Fig. 9 Signal traces

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Switching Power Supplies

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FLOETH ELECTRONIC

HVxHHSC-30 I/A Series Application Note

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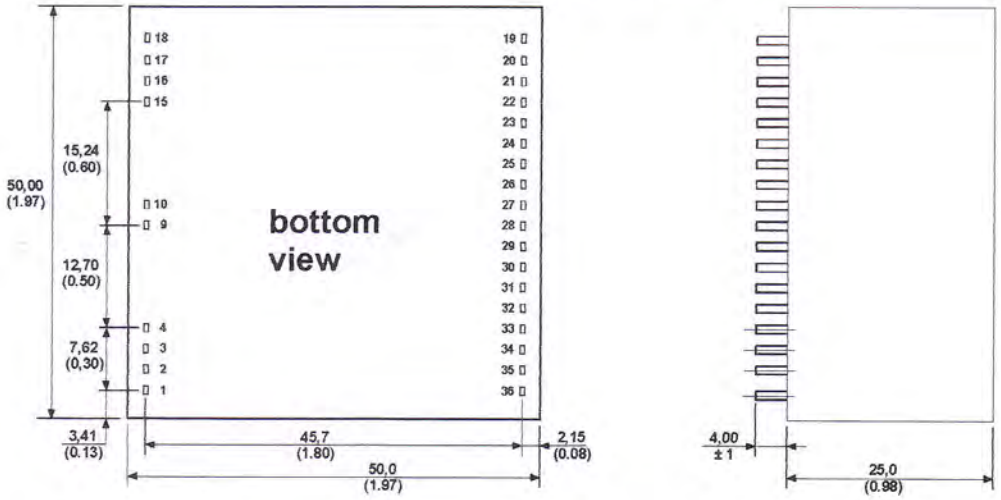
PACKAGE DETAILS

For further package information, please visit our website or contact Customer Services. All dimensions in mm, unless stated otherwise. DO NOT SCALE.

clearance & creepage greater than 40mm depends on solder eye size



Material information:
Drivers are epoxy moulded within a 50 x50 x25mm enclosure.

PCB and Epoxy materials are self-extiguishing in accordance with UL/CSA requirements

Mechanical dimensions:
Grid; 2,54mm
Solder pads: 1,6mm
Drill holes: 0,9mm

Fig. 11 Driver module outline