APPENDIX-A

USING DEVELOPMENT TOOLS

A.1 Programming AT89C51ED2

Following steps should be executed in sequence to program AT89C51ED2 micro-controller.

1. Compile the whole project using Keil uv3 and generate hex file.
2. The hex file can be downloaded (programmed) into AT89C51ED2 using any third party programmer e.g. Crystal Programmer as shown in Figure A-1.
3. Run the P4MIC software and read the hex file into buffer.
4. Go to Device & select the ATMEL AT89C51ED2 controller.
5. Go to Function tab & then click on Auto, which will do all necessary steps automatically & the hex file will be downloaded into micro-controller.

Figure A-1 Crystal Programmer

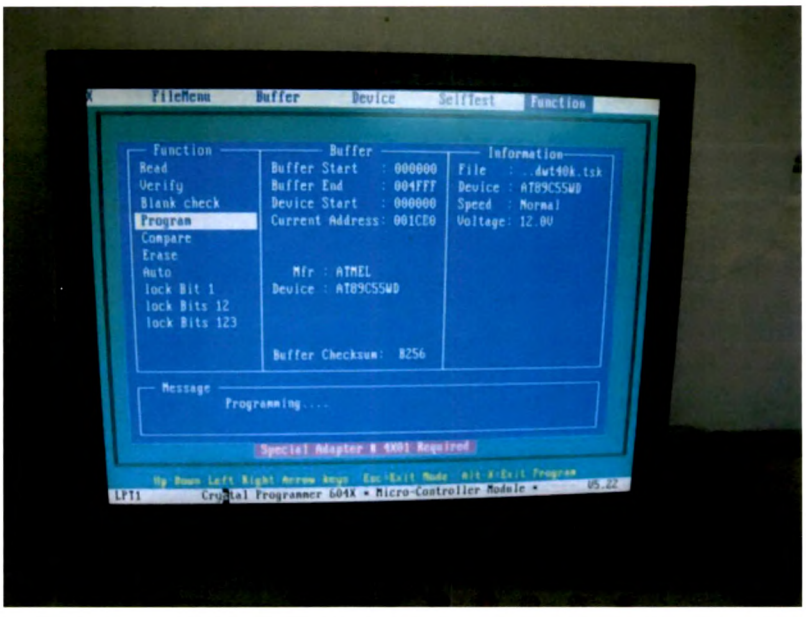


Figure A-2 Programming window

A.2 Keil Real View Project Creation

Follow the steps to create embedded controller project.

1. Open Keil Real View/Keil uv4.
2. Click the New uvision project button to launch the New Project Wizard.
3. Provide name and location for the project as shown in Figure A-3.
4. Choose CPU as NXP LPC2478 and press ok.
5. The start-up file will be automatically loaded.

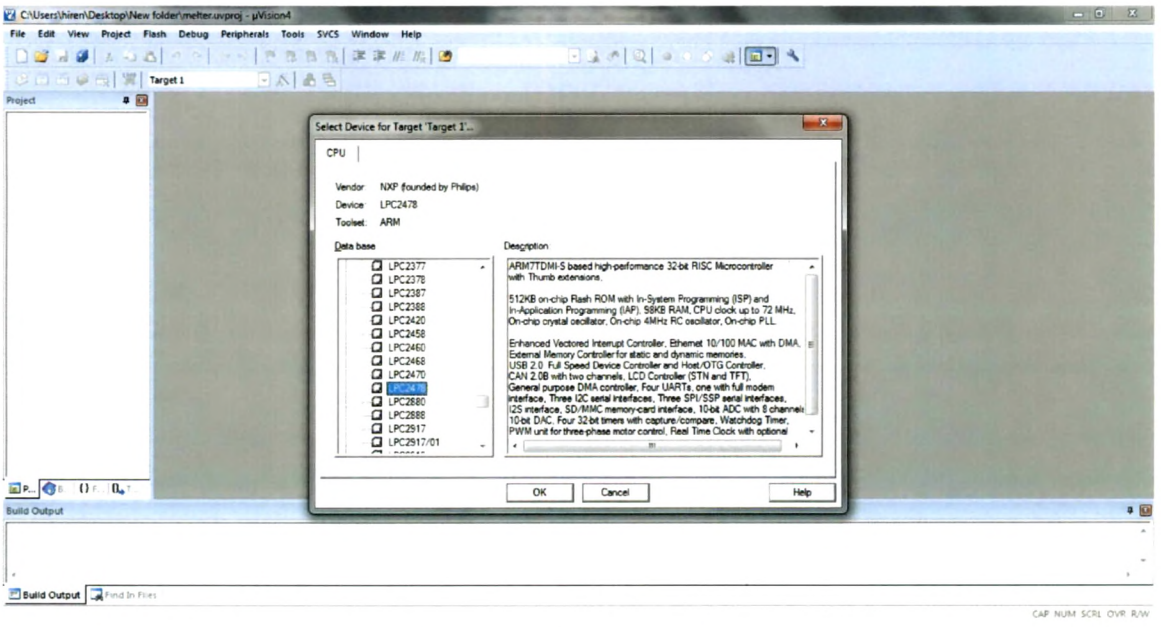


Figure A-3 New Project wizard

6. In Project window double click on LPC2400.S and configure external dynamic & static memory interface by entering into Configuration Wizard as shown in Figure A-4.

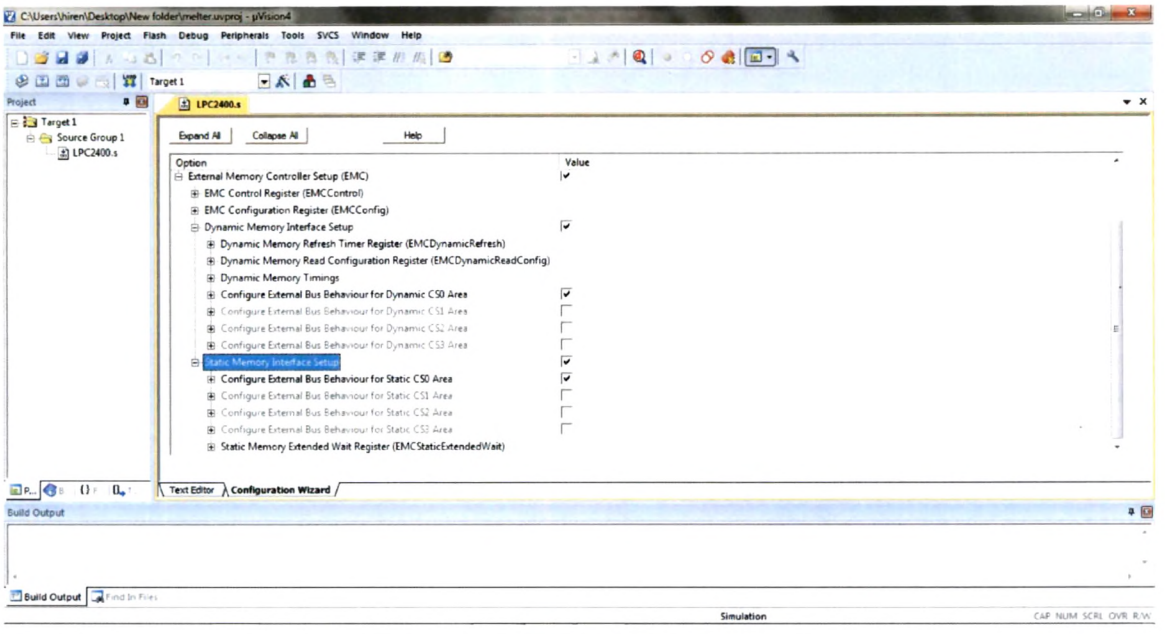


Figure A-4 Configuration wizard

7. Add groups as shown in the Figure A-5 and add c files and distribute whole program into different groups & files.

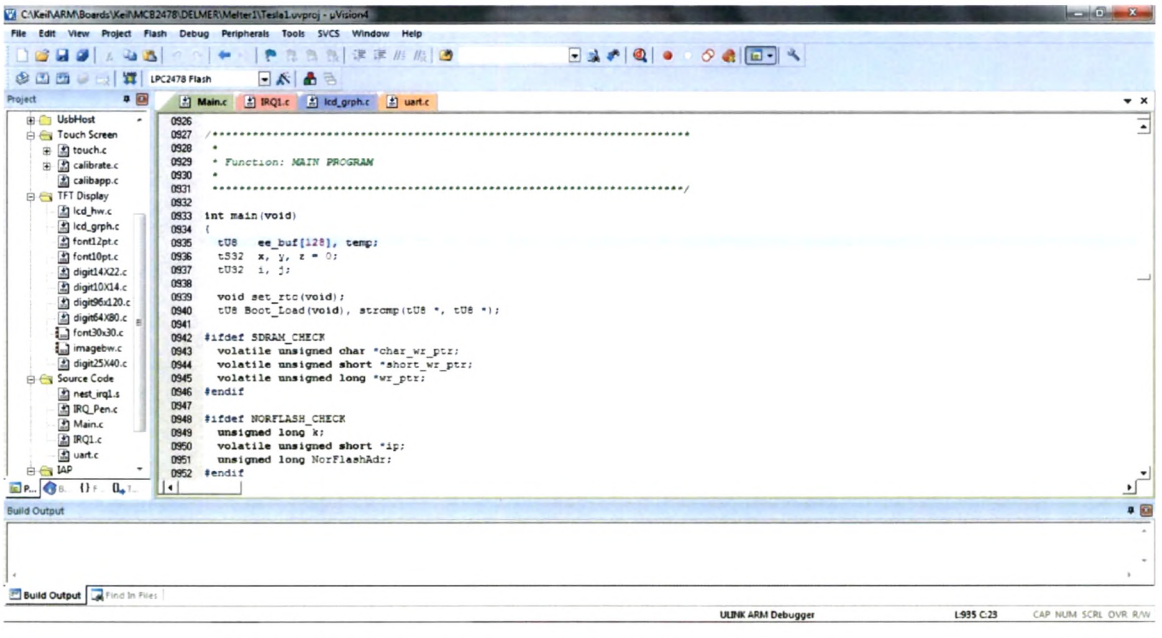


Figure A-5 Project Creation with Different groups

8. Once whole project is ready, click on Rebuild All target files button.
9. After successfully compiling the project, now it is ready to download and debug the project into actual hardware.
10. Connect a ULINK-2 converter between usb-port of PC and the Embedded hardware.
11. Press Debug button, the program will be downloaded into hardware & a debug window will open where the program can be executed step by step or the break points can be kept.

A.3 Eagle Schematic Design

Eagle 5.4 can be used to create schematic design & then to create artwork for manufacturing pcb.

Figure A-6 shows the schematic design created in Eagle 5.4.

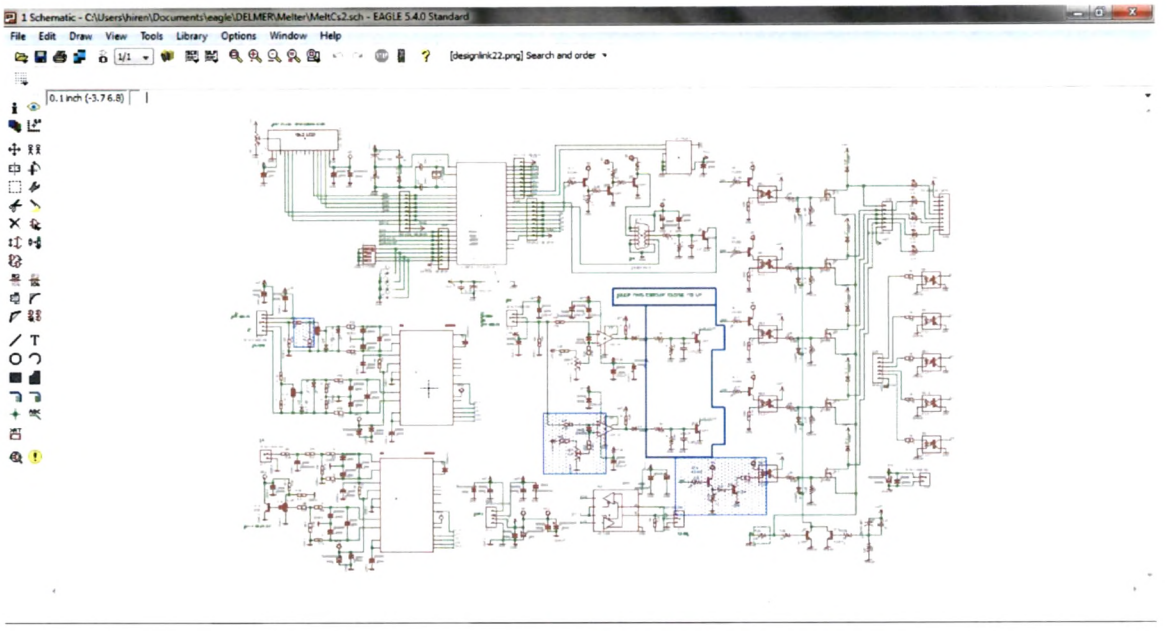


Figure A-6 Schematic Design in Eagle 5.4

A.3 Datasheet of IGBT

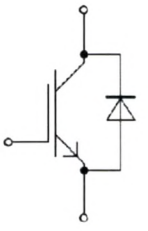
Technische Information / technical information

IGBT-Module
IGBT-modules

FZ600R12KE4

62mm C-Serien Modul mit Trench/Fieldstopp IGBT4 und Emitter Controlled 4 Diode
62mm C-Series module with Trench/Fieldstop IGBT4 and Emitter Controlled 4 diode

Vorläufige Daten / preliminary data



V_{CES} = 1200V
$I_{C\ nom}$ = 600A / I_{CRM} = 1200A

Typische Anwendungen
- Hochleistungsumrichter
- Motorantriebe
- USV-Systeme
- Windgeneratoren

Typical Applications
- High Power Converters
- Motor Drives
- UPS Systems
- Wind Turbines

Elektrische Eigenschaften
- Erweiterte Sperrschichttemperatur $T_{vj\ op}$
- Niedrige Schaltverluste
- Sehr große Robustheit
- V_{CEsat} mit positivem Temperaturkoeffizienten
- niedriges V_{CEsat}

Electrical Features
- Extended Operation Temperature $T_{vj\ op}$
- Low Switching Losses
- Unbeatable Robustness
- V_{CEsat} with positive Temperature Coefficient
- Low V_{CEsat}

Mechanische Eigenschaften
- 4kV AC 1min Isolationsfestigkeit
- Gehäuse mit CTI > 400
- Große Luft- und Kriechstrecken
- Isolierte Bodenplatte
- Standardgehäuse

Mechanical Features
- 4kV AC 1min Insulation
- Package with CTI > 400
- High Creepage and Clearance Distances
- Isolated Base Plate
- Standard Housing

Module Label Code

Barcode Code 128

DMX - Code

Content of the Code	Digit
Module Serial Number	1 - 5
Module Material Number	6 - 11
Production Order Number	12 - 19
Datecode (Production Year)	20 - 21
Datecode (Production Week)	22 - 23

prepared by: MK	date of publication: 2009-08-07	material no: 31516
approved by: WR	revision: 2.1	UL approved (E83335)

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Figure A-7a Datasheet of FZ600R12KE4 IGBT

Technische Information / technical information

IGBT-Module
IGBT-modules

FZ600R12KE4

infineon

Vorläufige Daten
preliminary data

IGBT-Wechselrichter / IGBT-inverter

Höchstzulässige Werte / maximum rated values

Kollektor-Emitter-Sperrspannung collector-emitter voltage	T_{vj} = 25°C	V_{CES}		1200	V
Kollektor-Dauergleichstrom DC-collector current	T_C = 100°C, T_{vj} = 175°C	$I_{C\ nom}$		600	A
Periodischer Kollektor Spitzenstrom repetitive peak collector current	t_P = 1 ms	I_{CRM}		1200	A
Gesamt-Verlustleistung total power dissipation	T_C = 25°C, T_{vj} = 175°C	P_{tot}		3000	W
Gate-Emitter-Spitzenspannung gate-emitter peak voltage		V_{GES}		+/-20	V

Charakteristische Werte / characteristic values

			min.	typ.	max.	
Kollektor-Emitter Sättigungsspannung collector-emitter saturation voltage	I_C = 600 A, V_{GE} = 15 V I_C = 600 A, V_{GE} = 15 V I_C = 600 A, V_{GE} = 15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$V_{CE\ sat}$		1,75 2,00 2,05	2,10	V V V
Gate-Schwellenspannung gate threshold voltage	I_C = 23,0 mA, V_{CE} = V_{GE}, T_{vj} = 25°C		V_{GEth}	5,2	5,8	6,4	V
Gateladung gate charge	V_{GE} = -15 V ... +15 V		Q_G		5,60		µC
Interner Gatewiderstand internal gate resistor	T_{vj} = 25°C		R_{Gint}		1,3		Ω
Eingangskapazität input capacitance	f = 1 MHz, T_{vj} = 25°C, V_{CE} = 25 V, V_{GE} = 0 V		C_{ies}		42,0		nF
Rückwirkungskapazität reverse transfer capacitance	f = 1 MHz, T_{vj} = 25°C, V_{CE} = 25 V, V_{GE} = 0 V		C_{res}		1,70		nF
Kollektor-Emitter Reststrom collector-emitter cut-off current	V_{CE} = 1200 V, V_{GE} = 0 V, T_{vj} = 25°C		I_{CES}			5,0	mA
Gate-Emitter Reststrom gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = 20 V, T_{vj} = 25°C		I_{GES}			400	nA
Einschaltverzögerungszeit (ind. Last) turn-on delay time (inductive load)	I_C = 600 A, V_{CE} = 600 V V_{GE} = ±15 V R_{Gon} = 1,2 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\ on}$		0,24 0,25 0,26		µs µs µs
Anstiegszeit (induktive Last) rise time (inductive load)	I_C = 600 A, V_{CE} = 600 V V_{GE} = ±15 V R_{Gon} = 1,2 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_r		0,09 0,10 0,11		µs µs µs
Abschaltverzögerungszeit (ind. Last) turn-off delay time (inductive load)	I_C = 600 A, V_{CE} = 600 V V_{GE} = ±15 V R_{Goff} = 1,2 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\ off}$		0,61 0,64 0,66		µs µs µs
Fallzeit (induktive Last) fall time (inductive load)	I_C = 600 A, V_{CE} = 600 V V_{GE} = ±15 V R_{Goff} = 1,2 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_f		0,10 0,14 0,15		µs µs µs
Einschaltverlustenergie pro Puls turn-on energy loss per pulse	I_C = 600 A, V_{CE} = 600 V, L_S = 60 nH V_{GE} = ±15 V, di/dt = 5500 A/µs (T_{vj}=150°C) R_{Gon} = 1,2 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{on}		35,0 50,0 55,0		mJ mJ mJ
Abschaltverlustenergie pro Puls turn-off energy loss per pulse	I_C = 600 A, V_{CE} = 600 V, L_S = 60 nH V_{GE} = ±15 V, du/dt = 3500 V/µs (T_{vj}=150°C) R_{Goff} = 1,2 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{off}		50,0 75,0 80,0		mJ mJ mJ
Kurzschlussverhalten SC data	V_{GE} ≤ 15 V, V_{CC} = 800 V V_{CEmax} = V_{CES} -L_{sCE} ·di/dt	t_P ≤ 10 µs, T_{vj} = 150°C	I_{SC}		2400		A
Innerer Wärmewiderstand thermal resistance, junction to case	pro IGBT / per IGBT		R_{thJC}			0,05	K/W
Übergangs-Wärmewiderstand thermal resistance, case to heatsink	pro IGBT / per IGBT λ_{Paste} = 1 W/(m·K) / λ_{grease} = 1 W/(m·K)		R_{thCH}		0,017		K/W

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Figure A-7b Datasheet of FZ600R12KE4 IGBT

Technische Information / technical information

IGBT-Module
IGBT-modules

FZ600R12KE4

infineon

Vorläufige Daten
preliminary data

Diode-Wechselrichter / diode-inverter

Höchstzulässige Werte / maximum rated values

Periodische Spitzensperrspannung repetitive peak reverse voltage	T_{vj} = 25°C		V_{RRM}	1200	V
Dauergleichstrom DC forward current			I_F	600	A
Periodischer Spitzenstrom repetitive peak forward current	t_P = 1 ms		I_{FRM}	1200	A
Grenzlastintegral I²t - value	V_R = 0 V, t_P = 10 ms, T_{vj} = 125°C V_R = 0 V, t_P = 10 ms, T_{vj} = 150°C		I²t	51000 49000	A²s A²s

Charakteristische Werte / characteristic values

				min.	typ.	max.	
Durchlassspannung forward voltage	I_F = 600 A, V_{GE} = 0 V I_F = 600 A, V_{GE} = 0 V I_F = 600 A, V_{GE} = 0 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	V_F		1,80 1,75 1,70	2,35	V V V
Rückstromspitze peak reverse recovery current	I_F = 600 A, - di_F/dt = 5500 A/µs (T_{vj}=150°C) V_R = 600 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	I_{RM}		440 560 590		A A A
Sperrverzögerungsladung recovered charge	I_F = 600 A, - di_F/dt = 5500 A/µs (T_{vj}=150°C) V_R = 600 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	Q_r		55,0 100 115		µC µC µC
Abschaltenergie pro Puls reverse recovery energy	I_F = 600 A, - di_F/dt = 5500 A/µs (T_{vj}=150°C) V_R = 600 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{rec}		27,0 52,0 60,0		mJ mJ mJ
Innerer Wärmewiderstand thermal resistance, junction to case	pro Diode / per diode		R_{thJC}			0,07	K/W
Übergangs-Wärmewiderstand thermal resistance, case to heatsink	pro Diode / per diode λ_{Paste} = 1 W/(m·K) / λ_{grease} = 1 W/(m·K)		R_{thCH}		0,024		K/W

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Figure A-7c Datasheet of FZ600R12KE4 IGBT

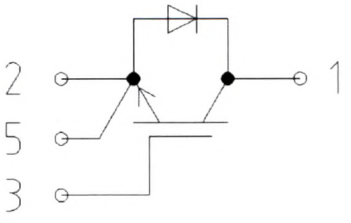
Technische Information / technical information

IGBT-Module
IGBT-modules

FZ600R12KE4

Vorläufige Daten
preliminary data

Schaltplan / circuit diagram



Gehäuseabmessungen / package outlines

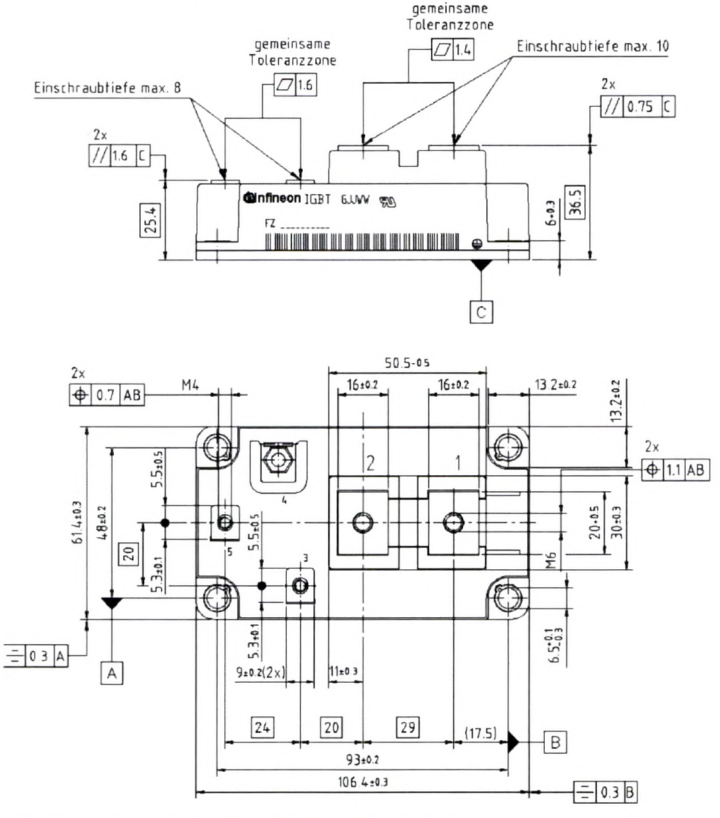


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Figure A-7d Datasheet of FZ600R12KE4 IGBT