2UCD120000E001_J

PCS100 UPS-I

Industrial Uninterruptable Power Supply

User Manual

ABOUT THIS DOCUMENT

Introduction

Voltage sags, surges and short outages are common events that often cause electric and electronic equipment to malfunction. When such events occur in critical control operations, they can cause the complete shutdown of a facility. T
he PCS100 UPS-I is an industrial strength uninterruptible power supply designed to solve these problems. It is a robust single conversion UPS for industrial or commercial loads. It is used to protect sensitive loads from sags, surges and outages using Ultracapacitor or battery energy storage.
For a comprehensive overview of publications available for the PCS100 UPS-I, refer to the inside cover of this publication. Web links and QR code are also included.

The Company

We are an established world force in the design and manufacturing of power electronics and power protection equipment.
As part of ABB, a world leader in electrical technology, we offer customers application expertise, service, and support worldwide.
We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.
The quality, accuracy and performance of the Company's products result from over 100 years' experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

Quality Control

The products listed in this catalogue are manufactured in an ISO 9001 accredited facility.

TELARC REGISTERED ISO 9001 Registration No. 2469

For More Information

Further publications for the PCS100 UPS-I are available for free download from
http://new.abb.com/ups/systems/industrial-ups/pcs100-ups-i
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This Document

This manual contains information regarding:

- the general functions of the PCS100 UPS-I
- the component enclosures making up the PCS100 UPS-I
- operation of the PCS100 UPS-I
- the user interface (GDM)
- control and adjustments of the PCS100 UPS-I

Usage

This manual should be used during operation and adjustment of the PCS100 UPS-I. It should be referenced for:

- commissioning the PCS100 UPS-I
- servicing
- operation and adjustment of the PCS100 UPS-I

Who Should Read This Manual?

This manual is intended for:

- installation personnel
- service personnel
- maintenance personnel
- operators

Prerequisites

An installation/repair/operator person working with the PCS100 UPS-I must:

- be trained by ABB and have electrical operational and safety knowledge

have sufficient training to operate in an accidental touch safe service environment

Hardware Revision

This User Manual applies to PCS100 UPS-I systems with:

- Ultracapacitor Energy Storage Enclosures Mk2
- Utility Disconnect Enclosure Mk2

Software Revision

This manual applies to PCS100 UPS-I systems with software revision R2JX.

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SAFETY

Safety Instructions

AR	تحذير :جهد كهربائي خطر ! .راجع تعليمات التشغيل افصل الكهرباء وقم بتأمينها قبل العمل في هذا الجهاز . تنبيه !يجب عدم التركيب إلا من خلال شخص على دراية بمجال التقنية الكهربائية
BG	Предупреждение: Опасно напрежение! Вижте инструкциите за работа. Изключете и блокирайте захранването преди да работите с устройството. Внимание! Да се монтира само от експерт електротехник.
CS	Varování: Nebezpečné napětí! Viz návod k obsluze. Před zahájením prací na tomto zařízení odpojte a uzamkněte napájení. Pozor! Toto zařízení smí instalovat pouze osoba s elektrotechnickou odborností.
DA	Advarsel: Farlig elektrisk spænding! Se betjeningsvejledningen. Frakobl enheden, og afbryd strømforsyningen, før du arbejder med denne enhed. Giv agt! Installation må kun foretages af personer med elektroteknisk ekspertise.
DE	Warnung: Gefährliche Spannung! Siehe Bedienungsanleitung. Vor dem Arbeiten Gerät ausschalten und von der Spannungsversorgung trennen. Achtung! Installation nur durch elektrotechnische Fachkraft.
EL	Προειδοποίηση: Επικίνδυνη τάση! Ανατρέξτε στις οδηγίες λειτουργίας. Αποσυνδέστε και απομονώστε την παροχή ισχύος προτού ξε κινήσετε τις εργασίες σε αυτήν τη συσκευή. Προσοχή! Η εγκατάσταση πρέπει να γίνεται μόνο από αδειούχο ηλεκτρολόγο εγκαταστάτη.
EN	Warning: Hazardous voltage! Refer to installation instructions. Disconnect and lock out power before working on this device. Attention! Installation by person with electrotechnical expertise only.
IT	Attenzione: Tensione pericolosa! Fare riferimento alle istruzioni per l'uso. Prima di intervenire su questo dispositivo, scollegare e isolare tutte le fonti di alimentazione. Attenzione! L'installazione deve essere eseguita esclusivamente da un installatore qualificato.
LT	Įspėjimas: Pavojinga įtampa! Žr. naudojimo instrukcijas. Atjunkite ir laikinai užblokuokite maitinimą prieš dirbdami su šiuo įrenginiu. Dėmesio! Įrengti gali tik asmuo, turintis elektrotechniko patirties.
LV	Brīdinājums: Bīstams spriegums! Skatiet darba norādījumus. Pirms sākat darbu ar šo ierīci, atvienojiet un bloķējiet strāvas padevi. Uzmanību! Uzstādīšanu drīkst veikt tikai persona ar zināšanām par elektrotehniku.
NL	Waarschuwing: Gevaarlijke spanning! Raadpleeg de bedieningsinstructies. Koppel dit apparaat los van de stroomvoorziening voordat u werkzaamheden uitvoert. Let op! Installatie mag alleen worden uitgevoerd door een monteur met elektrotechnische expertise.
NO	Advarsel: Farlig spenning! Se i bruksanvisningen. Koble fra og steng av strømmen før du arbeider på denne enheten. Forsiktig! Montering skal kun utføres av kvalifiserte personer med elektrokompetanse.
PL	Ostrzeżenie: Niebezpieczne napięcie! Patrz: instrukcja obsługi. Przed rozpoczęciem wykonywania pracy z tym urządzeniem odłącz i zablokuj zasilanie. Uwaga! Montaż może wykonywać wyłącznie osoba posiadająca doświadczenie elektrotechniczne.
PT	Aviso: Tensão perigosa! Consulte as instruções de operação. Desconecte e desligue a energia elétrica antes de trabalhar nesse dispositivo. Atenção! A instalação deve ser feita apenas por uma pessoa com especialidade eletrotécnica.
RO	Avertisment: Tensiune electrică periculoasă! Consultați instrucțiunile de utilizare. Deconectați și închideți sursa de energie înainte de a lucra cu acest dispozitiv. Atenție! Instalare

ES	Advertencia: ¡Tensión peligrosa! Consulte las instrucciones de funcionamiento. Antes de trabajar con este dispositivo, desconecte y bloquee la corriente. ¡Atención! La instalación debe ser realizada únicamente por un técnico electricista.
RU	Внимание: Опасное электрическое напряжение! Обратитесь к инструкциям по эксплуатации. Отключите питание и обесточьте устройство перед началом работ. Внимание! Установка должна выполняться только специалистом по электротехническим работам.
ET	Hoiatus: Elektrilöögi oht! Lisateavet vaadake kasutusjuhendist. Enne selle seadmega töötamist ühendage lahti ja lukustage toide. Tähelepanu! Seadet tohib paigaldada ainult elektrotehnilise kogemusega isik.
SK	Výstraha: Nebezpečné napätie! Pozrite si návod na použitie. Pred začatím prác na tomto zariadení odpojte a zablokujte napájanie. Pozor! Inštaláciu smie vykonávať len osoba s odbornými znalosťami v oblasti elektrotechniky.
FI	Varoitus: Vaarallinen jännite! Katso käyttöohje. Katkaise virta ja estä virran kytkeminen lukituksella ennen töiden aloittamista. Huomio! Asennuksen saa suorittaa vain henkilö, jolla on kokemusta sähkötekniikasta.
SL	Opozorilo: Nevarna napetost! Glejte navodila za uporabo. Pred delom na tej napravi izklopite in zaklenite električno napajanje. Pozor! Namestitev sme izvesti samo elektrotehnični strokovnjak.
FR	Avertissement: Tension dangereuse! Consultez les consignes d'utilisation. Débranchez et verrouillez l'alimentation électrique avant d'entreprendre des travaux sur cet appareil. Attention! L'installation doit être effectuée uniquement par une personne ayant une expertise en électrotechnique.
SV	Varning: Livsfarlig spänning! Se i bruksanvisningen. Frånkoppla och blockera anläggning eller en anläggningsdel innan arbeite utförs. Obs! Får endast installeras av behörig elektriker.
HR	Upozorenje: Opasan napon! Pogledajte upute za uporabu. Odspojite i isključite struju prije rada na ovom uređaju. Pažnja! Ugradnja je dopuštena samo osobama stručnim u području elektrotehnike.
TR	Uyarı: Tehlikeli gerilim! Çalışma talimatlarına bakın. Bu cihaz üzerinde çalışmadan önce elektriği kesin ve kilitleyin. Dikkat! Yalnızca elektroteknik uzmanlığa sahip kişiler tarafından kurulabilir.
HU	Figyelmeztetés: Veszélyes feszültség! Lásd a használati utasítást. Válassza le és zárja ki az áramellátást, mielőtt a berendezésen dolgozni kezd. Figyelem! Az üzembe helyezést csak elektrotechnikai szakértelemmel rendelkező személy végezheti el.
ZH	警告：高压危险! 请参见操作手册 操作本设备前请断开并锁定电源。 注意！安装仅限专业电工人员。

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Safety Notices

This manual contains important information regarding the operation of the ABB PCS100 UPS-I Industrial Uninterruptable Power Supply and provides technical and operational guidance for operators. The following safety instructions are to be observed.

This manual does not provide sufficient information for safe service of the PCS100 UPS-I. For such service information refer to appropriate manual.

This manual does not provide sufficient information for safe service of the PCS100 AVC-40. For such service information refer to appropriate manual.

CAUTION – Trained Operators
All operations on the PCS100 UPS-I must only be carried out by a trained Operator familiar with the contents of this manual. Hazardous conditions could arise from incorrect adjustment.

DANGER – Hazardous Voltages
An Operator must not open doors or panels marked as containing hazardous voltages. Many parts in this product, including printed circuit boards operate at lethal voltages. DO NOT TOUCH components or connections that have voltage present

DANGER – Arc Flash
Shorted terminals can cause arc flash resulting in severe burns, severe eye injury, blindness or death. Use insulated tools and do not short any terminals. Wear appropriate personal protective equipment.

DANGER – Stored Charge
Stored charge is present after the device is switched off. When the PCS100 UPS-I is powered down lethal voltages (+/- 375 Vdc) will remain in the energy storage element and the complete PCS100 UPS-I should be considered live.

DANGER – Potential Material Hazard of Batteries and Ultracapacitors
Under normal operation batteries and Ultracapacitors do not pose a risk to safety, however incorrect operating or handing, or physical damage could result in hazardous conditions. See the links and QR codes in this User Manual to the appropriate Material Safety Data Sheets.

DANGER – Protective Covers
Normal operation of this product requires any protective covers to be in place and doors secured closed.

DANGER – Personal Protection Equipment
Ensure safety glasses are worn while working if any part of the unit could be energized.
Ensure appropriate safety footwear is worn if inserting or removing modules or components from the product.

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1 OVERVIEW

The ABB PCS100 UPS-I is a high performance high efficiency UPS system that ensures protection from power quality events, enabling continuous power supply to modern industrial processes.
To supply continuous power during utility events the PCS100 UPS-I uses a modular energy storage and inverter system.
The energy storage is either batteries or Ultracapacitors with the choice of technology dependent on the autonomy required.
Battery systems can deliver autonomy up to several minutes.
Ultracapacitors provide seconds of autonomy (ride through time) for short power quality events, which are the most common problems encountered.
Ultracapacitors have extremely high power density and long lifetime resulting in a very compact and low maintenance solution.
Harsh electrical environments are often found in modern industry. The PCS100 UPS-I uses a robust high speed power electronic disconnect switch to disconnect the utility from the load.
The modular inverter construction and fail-safe electromechanical bypass provides the highest system availability.
Coupled with the small footprint and easy serviceability, this low maintenance, high efficiency industrial UPS is the solution for all power protection applications.

1.1. User Benefits

- Robust fail-safe modular industrial design
- Long lifetime energy storage
- Small footprint
- Highest efficiency and availability
- Low maintenance requirements
- Easy serviceability

1.2. Features

- Very high efficiency (99% typical)
- Designed specifically for industrial loads (motors, drives, transformers, production tools)
- Modular design providing high reliability and typically 30 minutes MTTR (mean time to repair)
- Very high fault current capacity
- Advanced Ultracapacitor or high discharge rate battery storage
- Generator walk-in algorithm for a controlled transfer of the load to backup generators
- Ratings from 150 kVA to 3000 kVA and voltages 208 Vac to 480 Vac

1.3. PCS100 UPS-I Advantages Compared to Alternative Solutions

- Robust with high availability
  - Designed for harsh electrical environments
  - Modular design
- Lowest cost of ownership
  - Highest efficiency
  - Long lifetime energy storage
- Small footprint
  - Ultracapacitor or battery storage options

1.4. Applications and Industries

ABB's PCS100 UPS-I is the ideal solution for protecting loads in factories and manufacturing plants across a wide range of industries including:

- IT
- Commerce
- Semiconductor
- Automotive
- Pharmaceutical
- Chemical
- Textile

For example, the PCS100 UPS-I is used to protect:

- Data center HVAC and servers
- Semiconductor fabrication, test and assembly lines
- Machining centers, CNC machines
- Printing machines
- Carbon fiber manufacturing
- High-speed packaging lines
- Plastic film manufacturing

1.5. PCS100 Power Protection Portfolio

The PCS100 UPS-I is part of the PCS100 Power Protection portfolio, as shown below. Each product is tailored to address specific power quality problems:

PCS100 AVC Active Voltage Conditioner	PCS100 UPS-I Industrial UPS	PCS100 RPC Reactive Power Conditioner
Utility sag and surge correction Load voltage regulation	Utility deep sag and surge correction Utility outage protection	Load created sag correction Power Factor correction Harmonic mitigation Unbalance correction

Table 1-1: PCS100 Power Protection portfolio

2 FUNCTIONAL DESCRIPTION

2.1 How it works

When the utility voltage is normal, the load is supported directly by the utility.
When a sag, surge or outage occurs, the PCS100 UPS-I immediately transfers the load onto its inverter. Power is provided by battery or Ultracapacitor energy storage.
Batteries are typically used to bridge start-up time for generator backup systems where critical applications may be subject to longer supply outages.
Ultracapacitors are ideal for protecting the load from sags and short-term outages or to bridge the switching time to another feeder.

Figure 2-1: PCS100 UPS-I concept

2.2 Single Line Diagram

The ABB PCS100 UPS-I is a robust single conversion UPS providing continuous current flow to the load during transfer due to the revolutionary high speed Utility Disconnect and fast PCS100 Inverter technology. The modular inverter construction and robust Fail-Safe Bypass provides the highest efficiency and system availability. The single conversion design with Coupling Transformer enables simple, low footprint construction with wide range of operation voltages, galvanic isolation of DC Energy Storage system and robustness for industrial loads.

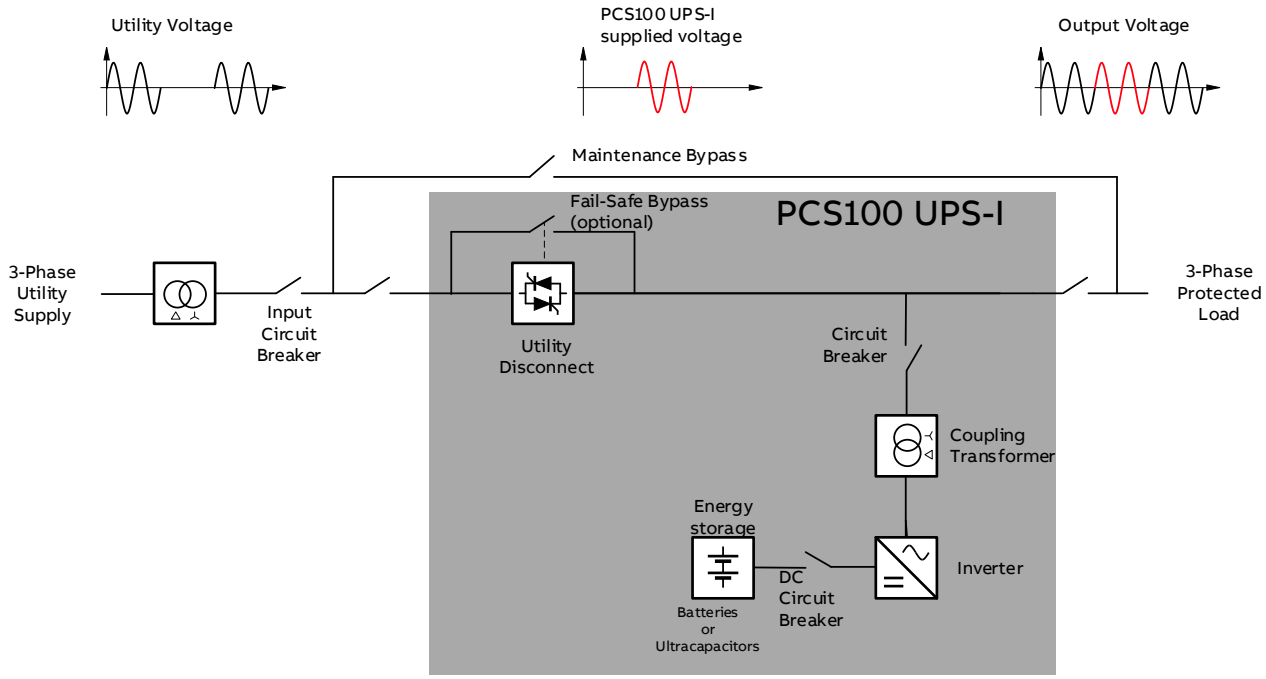


Figure 2-2: PCS100 UPS-I Single line diagram

2.3 Operation

The following diagrams show how the PCS100 UPS-I behaves when a utility disturbance occurs, and what happens when the Fail-Safe Bypass is operating.

> Note: The following diagrams show a Fail-Safe Bypass. In some PCS100 UPS-I models the Fail-Safe Bypass is integrated and for other models it is optional.

2.3.1 Utility Voltage within Limits

The power to the load is supplied from the utility (Online mode). Inverters are idling and maintain synchronization with the utility voltage to allow instant operation in the case of a utility disturbance. A Float Charger (not shown) maintains the state of charge of the battery or Ultracapacitor storage.

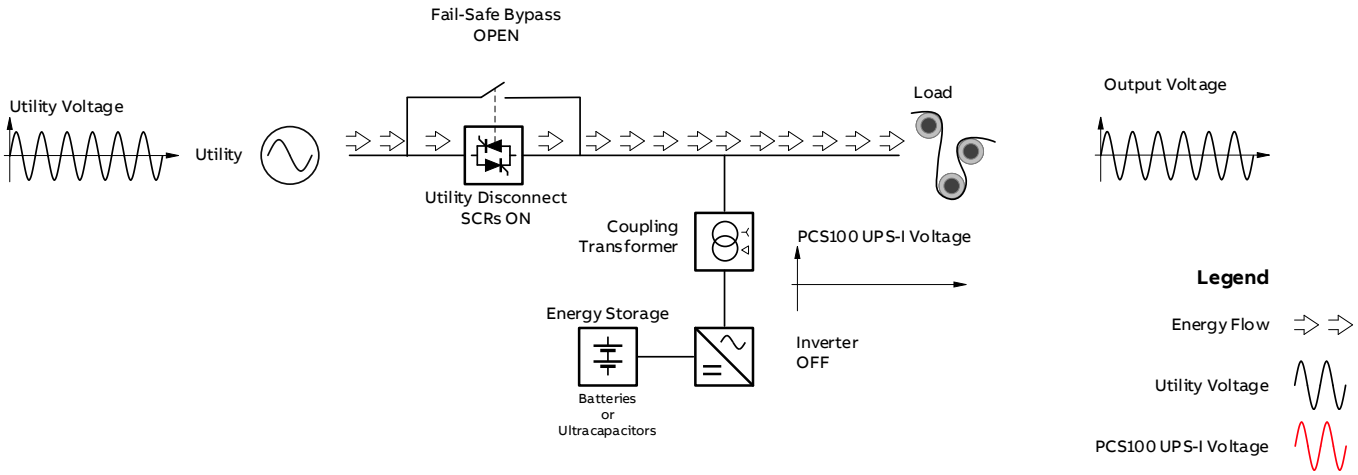


Figure 2-3: PCS100 UPS-I energy flow in case of utility supply within limits

2.3.2 Utility Disturbance Occurs

When the utility voltage deviates from user defined limits, due to voltage sags, surges, under-voltages, over-voltages or outage, the PCS100 UPS-I inverters begin supplying power to the load (Discharge mode). At the same time the utility is disconnected, isolating the PCS100 UPS-I output and load from the utility. ABB's own inverter commutation technique is used to ensure the Utility Disconnect SCR's are commutated off as fast as possible, minimizing any disturbance to the load.

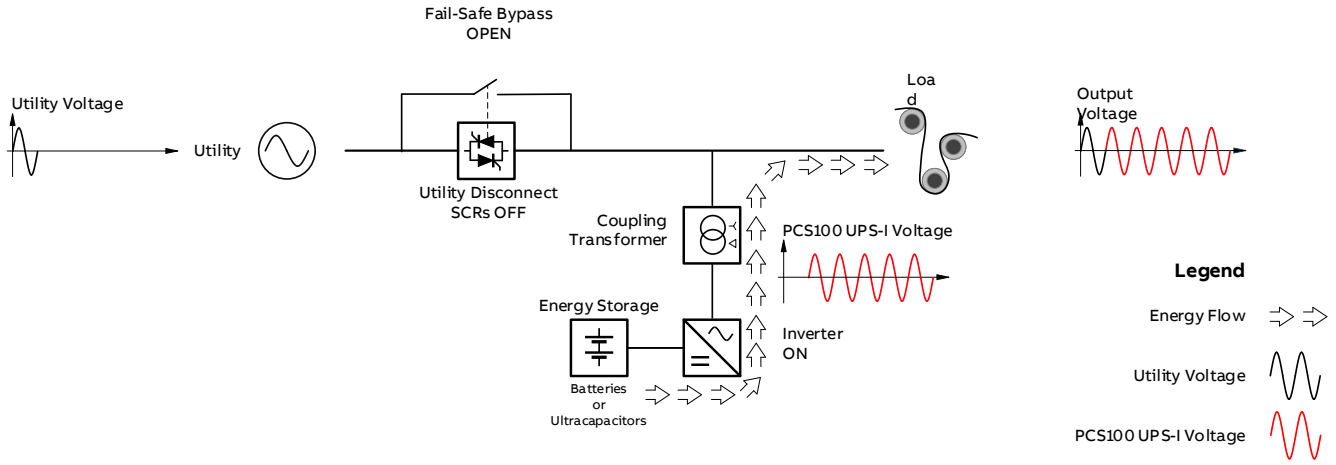


Figure 2-4: PCS100 UPS-I energy flow in case of utility supply disturbance

2.3.3 Utility Voltage Returns

When the voltage returns within user defined limits the PCS100 UPS-I synchronizes with the utility voltage then closes the Utility Disconnect. If required the PCS100 UPS-I can softly transfer the load from the inverter to the utility or generator using the generator walk-in function. Once the load is transferred, power to the load is again supplied by the utility. The PCS100 UPS-I energy storage is then rapidly recharged by the inverters.

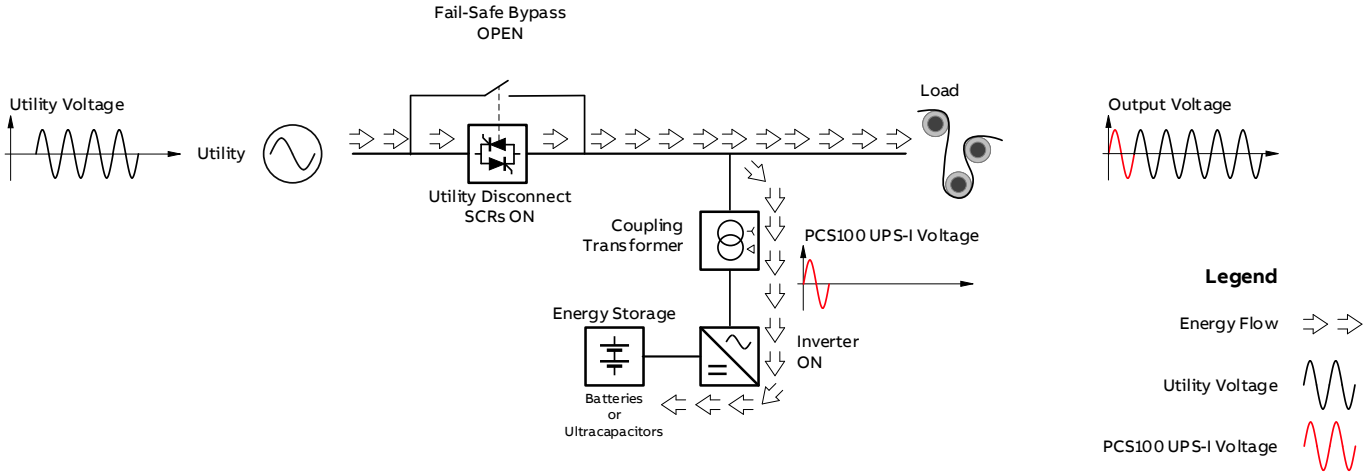


Figure 2-5: PCS100 UPS-I energy flow in case of charging

For detailed information on Energy Storage charging refer to section 9.4.

2.3.4 Voltage Operating Range

Figure 2-6 shows typical voltage operating range with Ultracapacitor Energy Storage (1.0 Power Factor when new). For exact autonomy time at different load levels refer to the graph in section 6.1.3 which also includes aging impact on Ultracapacitor Energy Storage.

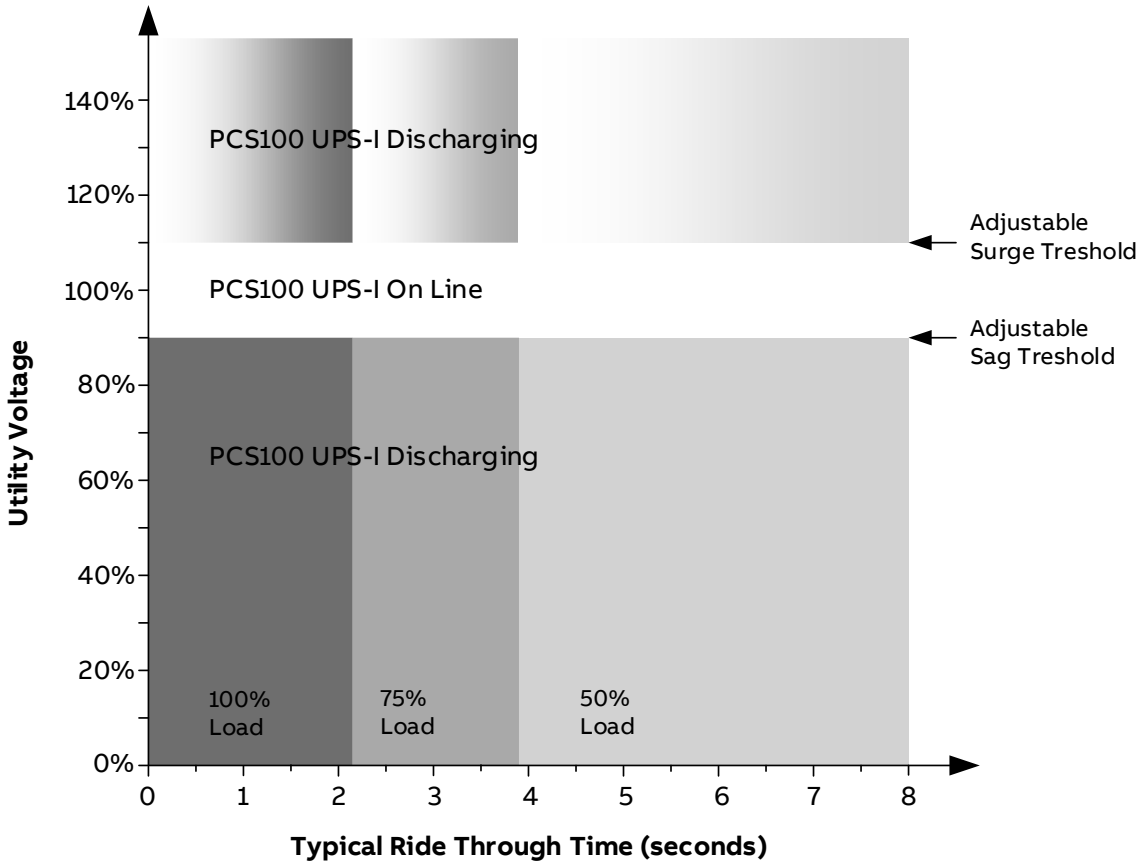


Figure 2-6: PCS100 UPS-I voltage operating range example

For detailed information on voltage detection and transfer performance refer to section 9.

2.3.5 Fail-Safe Bypass Operation

In an expected or unexpected PCS100 UPS-I shutdown, load current will be transferred to the Fail-Safe Bypass (where fitted). This provides an additional level of security by placing a mechanical contact in parallel with the Utility Disconnect.

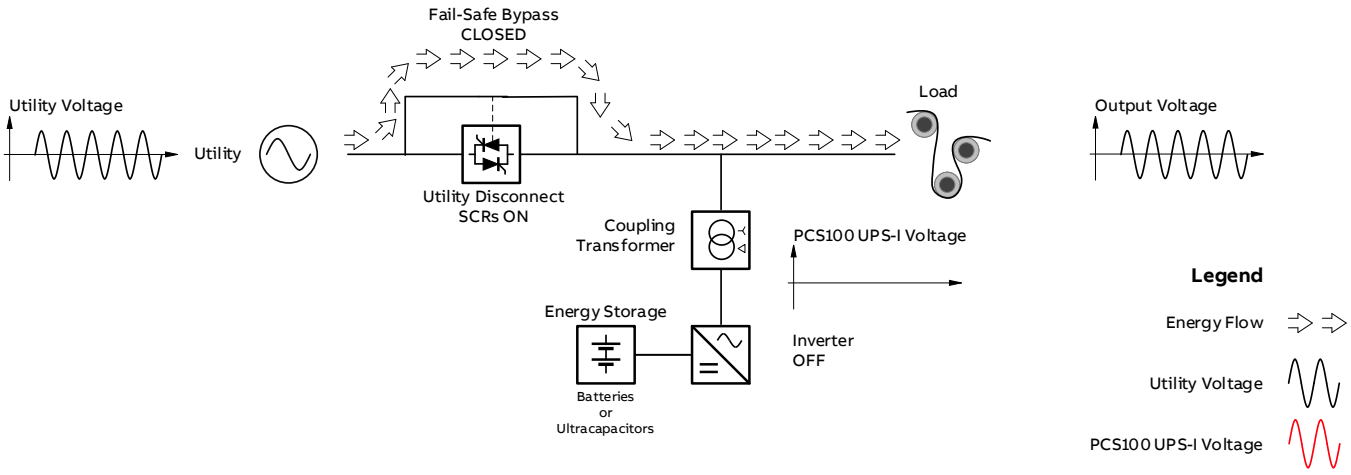


Figure 2-7: PCS100 UPS-I energy flow in case of bypass operation

2.4 Typical Applications

The PCS100 UPS-I may be applied to provide protection in low voltage systems. The following diagrams show typical applications providing protection to an entire factory and sensitive electronic loads within that factory.

CAUTION
The PCS100 UPS-I is designed for use in TN power systems. For any other type of power distribution system please refer to ABB document 2UCD120000E017, or contact the ABB factory for information. See Figure 19-1 for typical connection details.

Figure 2-8 shows a typical PCS100 UPS-I installation where the PCS100 UPS-I is used to protect the complete factory. The PCS100 UPS-I is installed between the incoming breaker and the factory LV distribution system.

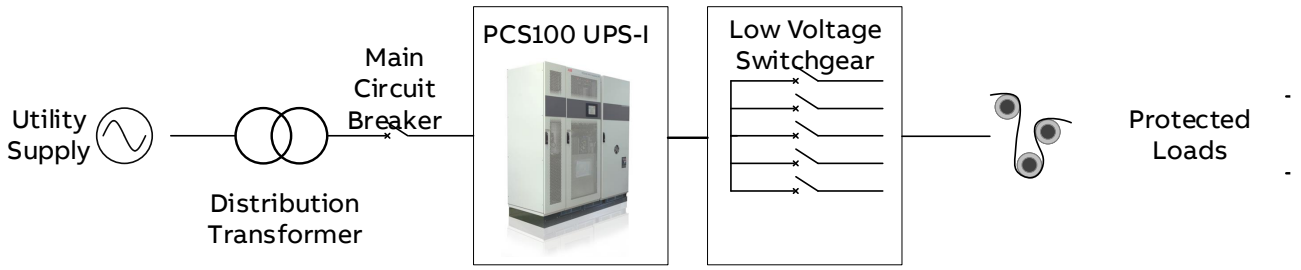


Figure 2-8: PCS100 UPS-I installation protecting the complete factory

Figure 2-9 shows typical PCS100 UPS-I installation where the PCS100 UPS-I is used to protect a specific load. The PCS100 UPS-I is installed within the LV distribution system, i.e. on the feeder supplying the specific load to be protected.

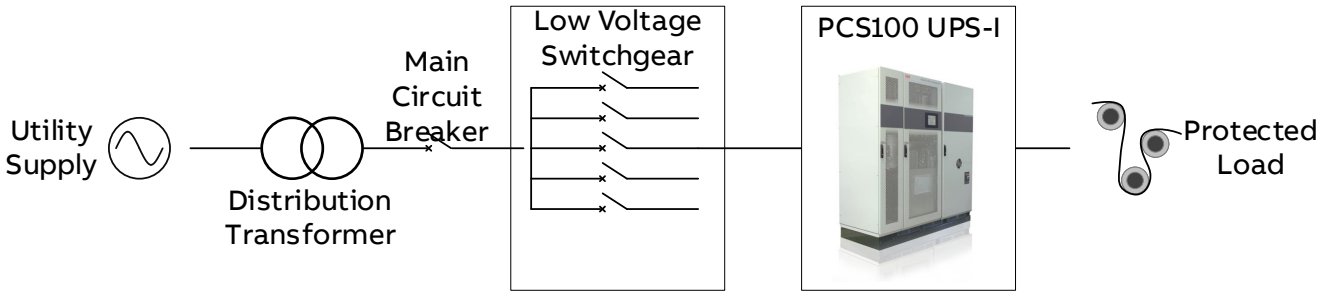


Figure 2-9: PCS100 UPS-I installation protecting a specific load

ABB recommends that a maintenance bypass (not supplied with the PCS100 UPS-I) is fitted. The maintenance bypass allows maintenance to be performed on the PCS100 UPS-I without disruption to the load.

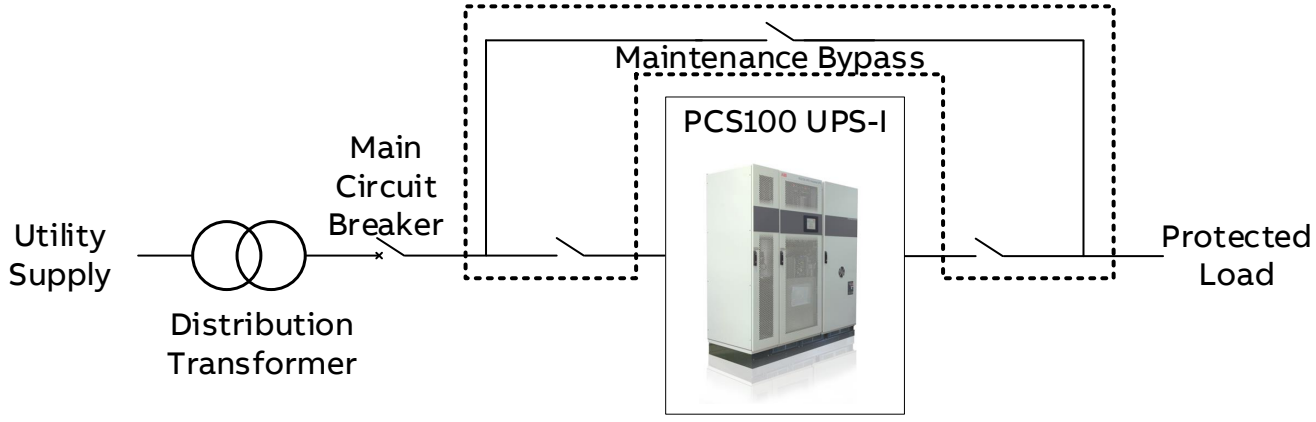


Figure 2-10: PCS100 UPS-I with maintenance bypass

3 MODEL DEFINITION

3.1 Type Code

The PCS100 UPS-I type code is given in the product tables. The type code is a unique code for the specific model PCS100 UPS-I and specifies all the components that are used to construct the model. From the base code given in the product tables options can be added to the type code. These options are called plus (+) codes.

The following diagram outlines the structure of the type code:

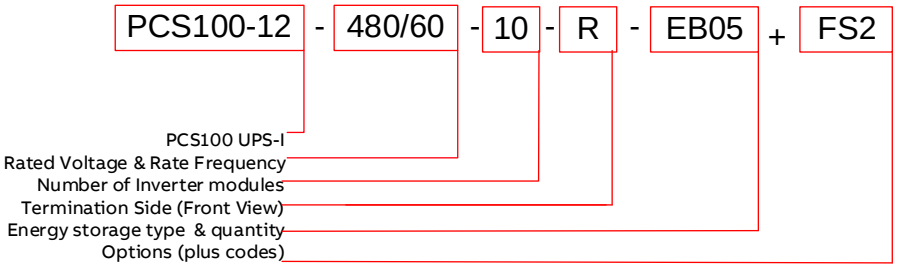


Figure 3-1: PCS100 UPS-I type code

3.1.1 Rated Voltage

This is the rated maximum voltage of the PCS100 UPS-I. Options are 480V, 400V and 220V. Other operating voltages (i.e. 380V) are achieved by software settings.

3.1.2 Rated Frequency

Options are 50 Hz and 60 Hz. 400 V models are only available at 50 Hz.

3.1.3 Number of Inverter Modules

The number of inverter modules needed depends on the load kVA. Each inverter module can deliver 150 kVA at the rated voltage. Table 3-2 provides the allowable number of modules that can be employed.

Note: Operation at lower than the rated voltage results in less kVA per module. Consult the rating tables in the UPS-I Technical Catalogue (document number 2UCD120000E002) for more information.

3.1.4 Termination Side

The location of the power terminals when viewed from the front of the PCS100 UPS-I. For 900 A and lower current systems the termination is always on the Left (L). For > 900A systems the termination is always on the Right (R).

3.1.5 Energy Storage

Energy storage can be Ultracapacitors (EC) or Batteries (EB). The following number indicates the quantity of strings of energy storage. For Ultracapacitors one string provides 300 kW of backup power. For batteries one string provides 240 kW of backup power. The number of strings required depends on the load kW rating.

3.1.6 Options

Options are described in document 2UCD120000E0025 PCS100 UPS-I Technical Catalogue.
The following options are available:

Plus Code	Option Description
+BB	Back-to-Back Layout Plan
+FS2	2200 A Fail-Safe Bypass
+FS4	4200 A Fail-Safe Bypass
+TE	Cable Termination Enclosure
+DMY	Dummy Enclosure
+NBxx	Empty Battery Energy Storage Enclosure

Table 3-1: PCS100 UPS-I available options

3.1 Rating label

The information relating to a specific PCS100 UPS-I is shown on its rating label inside the master inverter enclosure door.
Example rating label is shown below.

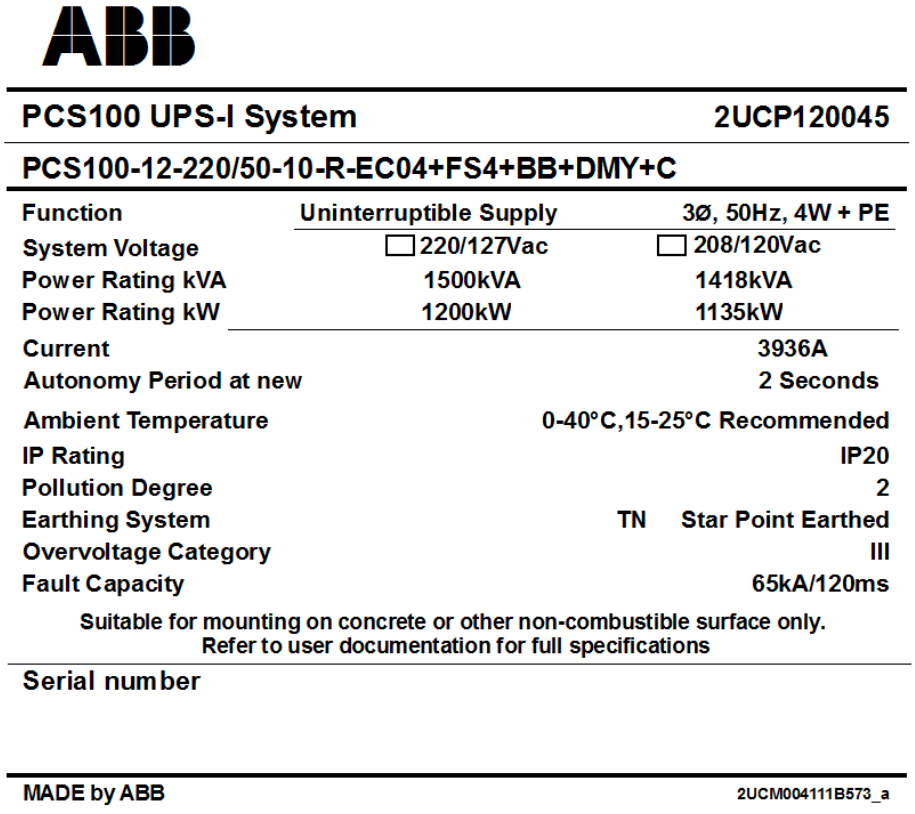


Figure 3-2: PCS100 UPS-I rating label

3.2 PCS100 UPS-I Model Range

The following Table 3-2 gives the models available.
This model range does not include energy storage.
For complete information with Ultracapacitor or Battery Energy Storage refer to document 2UCD120000E002 PCS100 UPS-I Technical Catalogue.

Rated power kVA @ rated voltage	**Inverter Rated Current** [A]	**Inverter Modules** Quantity	**Utility Disconnect Rated Current** [A]	**Terminal Position** (Utility & Load)	**Losses** kW (typical)	**Efficiency** % (typical)	**Airflow** (m^3/min) Standby	**Fault Capacity** (I_{cw}) kA / **Withstand Period** ms	**Frame Size**	**Type Code** **To complete the Type Code:** Place 5 for 50Hz or 6 for 60Hz in place of the **X**
220 V Models										
150	394	1	900	L	2.9	98.0	27	25 / 10	1xB	PCS100-12-220/x0-01-L
300	787	2	900	L	4.8	98.4	27	25 / 10	1xB	PCS100-12-220/x0-02-L
450	1181	3	2200	R	6.7	98.5	35	50 / 120	2xA 1xC	PCS100-12-220/x0-03-R
600	1575	4	2200	R	8.9	98.5	35	50 / 120	1xA 2xC	PCS100-12-220/x0-04-R
750	1968	5	2200	R	11.0	98.5	35	50 / 120	1xA 2xC	PCS100-12-220/x00-5-R
900	2362	6	4200	R	11.8	98.7	45	65 / 120	1xA 2xC	PCS100-12-220/x0-06-R
1200	3149	8	4200	R	15.7	98.7	45	65 / 120	2xA 2xC	PCS100-12-220/x0-08-R
1500	3936	10	4200	R	19.8	98.7	45	65 / 120	2xA 1xC 1xF	PCS100-12-220/x0-10-R
400 V Models[1]										
150	217	1	900	L	2.3	98.5	27	25 / 10	1xB	PCS100-12-400/50-01-L
300	433	2	900	L	3.3	98.9	27	25 / 10	1xB	PCS100-12-400/50-02-L
450	650	3	900	L	4.5	99.0	27	25 / 10	1xA 1xB	PCS100-12-400/50-03-L
600	866	4	900	L	5.9	99.0	27	25 / 10	1xB 1xC	PCS100-12-400/50-04-L
750	1083	5	2200	R	7.1	99.1	35	50 / 120	1xA 2xC	PCS100-12-400/50-05-R
900	1299	6	2200	R	7.7	99.1	35	50 / 120	1xA 2xC	PCS100-12-400/50-06-R
1200	1732	8	2200	R	10.1	99.2	35	50 / 120	2xA 2xC	PCS100-12-400/50-08-R
1500	2165	10	2200	R	12.6	99.2	35	50 / 120	2xA 1xC 1xF	PCS100-12-400/50-10-R
1800	2598	12	4200	R	14.3	99.2	45	65 / 120	2xA 1xC 1xF	PCS100-12-400/50-12-R
2100	3031	14	4200	R	16.7	99.2	45	65 / 120	3xA 1xC 1xF	PCS100-12-400/50-14-R
2400	3464	16	4200	R	18.9	99.2	45	65 / 120	3xA 1xC 1xF	PCS100-12-400/50-16-R

[1] It is possible to supply 400 V, 60 Hz models also. Please contact the factory.

Rated power kVA @ rated voltage	**Inverter Rated Current** [A]	**Inverter Modules** Quantity	**Utility Disconnect Rated Current** [A]	**Terminal Position** (Utility & Load)	**Losses** kW (typical)	**Efficiency** % (typical)	**Airflow** (m^3/min) Standby	**Fault Capacity** (I_{cw}) kA / **Withstand Period** ms	**Frame Size**	**Type Code** **To complete the Type Code:** Place 5 for 50Hz or 6 for 60Hz in place of the **X**
480 V Models										
150	180	1	900	L	2.3	98.5	27	25 / 10	1xB	PCS100-12-480/x0-01-L
300	361	2	900	L	3.2	98.9	27	25 / 10	1xB	PCS100-12-480/x0-02-L
450	541	3	900	L	4.3	99.1	27	25 / 10	1xA 1xB	PCS100-12-480/x0-03-L
600	722	4	900	L	5.5	99.1	27	25 / 10	1xB 1xC	PCS100-12-480/x0-04-L
750	902	5	900	L	6.6	99.1	35	50 / 120	1xA 2xC	PCS100-12-480/x0-05-L
900	1083	6	2200	R	7.1	99.2	35	50 / 120	1xA 1xB 1xC	PCS100-12-480/x0-06-R
1200	1443	8	2200	R	9.1	99.2	35	50 / 120	2xA 2xC	PCS100-12-480/x0-08-R
1500	1804	10	2200	R	11.2	99.3	35	50 / 120	2xA 1xC 1xF	PCS100-12-480/x0-10-R
1800	2165	12	2200	R	13.6	99.2	35	50 / 120	2xA 1xC 1xF	PCS100-12-480/x0-12-R
2100	2526	14	4200	R	14.9	99.3	45	65 / 120	3xA 1xC 1xF	PCS100-12-480/x0-14-R
2400	2887	16	4200	R	16.6	99.3	45	65 / 120	3xA 1xC 1xF	PCS100-12-480/x0-16-R

Table 3-2: PCS100 UPS-I model range (without energy storage)

Rated power kVA @ rated voltage	**Inverter Rated Current** [A]	**Inverter Modules** Quantity	**Utility Disconnect Rated Current** [A]	**Terminal Position** (Utility & Load)	**Losses** kW (typical)	**Efficiency** % (typical)	**Airflow** (m^3/min) Standby	**Fault Capacity** (I_{cw}) kA / **Withstand Period** ms	**Frame Size**	**Type Code** **To complete the Type Code:** Place 5 for 50Hz or 6 for 60Hz in place of the **X**
440V model[2] (Note: This model uses 2 x 440 V, 1.5 MVA transformer)										
3000	180	20	4200	R	23.5	99.3	45	65/120	4xA 2xC 2xF	PCS100-12-440/x0-20-L

Note:
208 V operation is achieved by setting a 220 V PCS100 UPS-I to 208 V.
380 V operation is achieved by setting a 400 V PCS100 UPS-I to 380 V.
415 V or 440 V operation is achieved by setting a 480 V PCS100 UPS-I to 415 V or 440 respectively.
This configuration is done at the factory and must be specified when ordering.

Note:
The Frame Size shown in Table 3-2 defines the standard PCS100 UPS-I in linear side-by side layout only. It does not include the optional Fail-Safe Bypass enclosure or dummy enclosure options. If needed, for Fail-Safe Bypass enclosure please add additional 1xC enclosure for a PCS100 UPS-I with load current greater than 900 A.

[2] Only available for Ultracapacitor Energy Storage. Please contact the factory.

Nominal ratings	
Rated power (kVA)	Rated power (kVA) at rated voltage and power factor.
Inverter Rated Current	Rated inverter current available during PCS100 UPS-I discharge mode
Utility Disconnect Rated Current	Rated UD current during PCS100 UPS-I online mode
Overload ratings	
Inverter	110% of rated current for 30 s
Utility Disconnect	120% of rated current for 60 s every 10 minutes 150% of rated current for 30 s every 10 minutes 200% of rated current for 10 s every 10 minutes 300% of rated current for 5 s every 10 minutes

Table 3-3: PCS100 UPS-I model range table definition explanations

4 TECHNICAL SPECIFICATION

NOTE: These specifications apply to the standard PCS100 UPS-I range and may be superseded by special variations stated on the PCS100 UPS-I rating label or User Manual Addendum.

4.1 Utility – Input

Rated Supply Voltage (Operating range)	220 V (208 – 220 V) 400 V (380 – 400 V) 480 V (415 - 480 V) Note: Operation at lower than the rated voltage results in less kVA per module. Consult the rating tables for more information.
Voltage tolerance	± 10%
Nominal supply frequency	50 Hz or 60 Hz
Frequency tolerance	± 5 Hz
Maximum Continuous Voltage	110%
Power system	3-phase + Neutral (4-Wire) Centre ground referenced (TN-S) For use in other power systems refer to ABB Document 2UCD120000E017
Harmonics	IEC 61000-2-4 Class 2 (Utility THDv < 8%) Note: For THDv > 8%, please refer to factory. For applications where THDv is above 10% lifetime of components may be significantly affected, please refer to factory.
Overvoltage category	III
Fault capacity	Refer to the model tables in this catalogue
Efficiency (400 V & 480 V models)	99% (typical)
Efficiency (220 V models)	98% (typical)
Overload and Short Circuit Protection	Circuit Breaker (not included)
Overload Capacity	120% for 60 s 150% for 30 s 200% for 10 s 300% for 5 s Not more than once every 10 minutes. For more information refer the Input Circuit Protection description in this catalogue

4.2 Load – Output

Capacity Rating	208-220V 400 V / 480 V	150 kVA to 1500kVA 150 kVA to 2400kVA
Displacement Power Factor of Connected Load	0.5 lagging to 0.9 leading	
Crest Factor for Rated kVA	2.0	
Maximum allowed motor load	25% of rated kVA Contact ABB for applications with greater than 25%	
Overload Capability – Inverter	110% for 30 s	
Load Imbalance	<10% of rated kVA See 9.7 for more detail. Contact ABB where load imbalance is greater than 10% of rated kVA	
Neutral Current	<5% of rated current See 9.7 for more detail. Contact ABB where neutral current is greater than 5% of rated current	

4.3 Inverter Supply

Maximum operating period	30 s at rated load
Transfer time	≤ 1.8 ms (typical)
Voltage Settling time	≤ 5 ms (typical)
Cooling	Air cooled; fan forced
Minimum output voltage	> 95% at end of discharge Note: Model and load dependent. Displacement power factor below 0.75 will incur greater voltage reduction.
Output Frequency	50 or 60 Hz Inverter frequency equals the supply frequency.
Frequency accuracy	0.10%
Overload capability	110% for 30 s
Voltage distortion	< 2.5% THDv for linear loads
Voltage unbalance (negative / positive sequence)	<3% for 100% unbalanced loads
Fault capacity (short circuit)	120% of rated current

4.4 Fail-Safe Bypass

900 A Utility Disconnect	Integrated normally closed contactors
2200 A & 4200 A Utility Disconnect	Optional air circuit breaker (ACB)
Overload Capability	150% for 500 s 200% for 300 s 300% for 120 s 500% for 30 s Note: Not more than once every 30 minutes.
Closing Time 900 A	20 ms
Closing Time 2200 & 4200 A	80 ms
Cooling	Convection

4.5 Coupling Transformer

Capacity Rating	110% of PCS100 UPS-I kVA rating for 30 s Note: Optimized for short-term performance.
Type	Dry
UL Insulation Class	N (200 °C)
Design Temperature	Temperature rises 60 °C for short-term full load operation
Typical Impedance	8% Note: The PCS100 UPS-I incorporates compensation for the voltage drop across the coupling transformer impedance.

4.6 Energy Storage - Ultracapacitors

System DC Nominal Voltage	750 V DC
Discharging Voltage Range	750 V DC to 554 V DC
Overload Capacity	100%
Rated Power	300 kW per string
Autonomy Period	2 s @ 300 kW For more information refer to the autonomy calculations in section 6.
Operating Temperature	15 °C to 25 °C (recommended)
Design Life	15 years at 25 °C
Cycle Life	> 500,000
Recharge Time	< 45 s

4.7 Energy Storage - Batteries

System DC Nominal Voltage	672V DC (56 x 12V DC)
Discharging Voltage Range	780 V DC to 554 V DC
Overload Capacity	100%
Rated Power	240 kW per string
Autonomy Period	30 s @ 240 kW For more information refer to ABB Document 2UCD120000E018
Operating Temperature	15 °C to 25 °C (recommended)
Design Life	10 years at 25 °C
Cycle Life	> 800 (full load 30 s discharge)
Recharge Time	< 30 min

4.8 Event Recording

Measurement Method	Line to Line
Sample Time	125 µs
Resolution of time stamp in event log	10 ms
Measurement Type	Half-cycle RMS according to IEC 61000-4-30

4.9 Environmental

Operating temperature range	0° C to 40° C (32° F to 104° F)
Operating altitude	< 1000 m without derating
Capacity derating with altitude	1% every 100 m above 1000 m 2000 m maximum
Humidity	< 95%, non-condensing
Pollution degree rating	2
Noise	< 75dBA @ 2 m
Storage temperature range	-30° C to 50° C (-22° F to 122° F)
Packaging	Must be kept dry at all times including transportation and storage. Protect against contact with rain or other water or liquids and do not store in damp or humid conditions.

4.10 Enclosure

Enclosure rating	IP20 / NEMA 1
Material	Electro-galvanized steel
Panel Thickness Side and Rear	1.5 mm
Panel Thickness Door	2 mm
Finish	Standard epoxy-polyester powder coating textured finish
Color	RAL7035
Enclosure Access	Hinged doors with key lock

4.11 User Interface

User Interface	10.1” color touch panel
Touch panel	Full parameter control
Control inputs	Start / Stop / Reset digital inputs
Control outputs	Running, warning and fault relays

4.12 Serial Comms

Access protocol	Ethernet connectivity Modbus TCP

4.13 Standards and Certifications

Declaration of Conformity – This product conforms to the following standards.

Quality	ISO 9001
Construction and Safety	EN 62477-1
Electromagnetic Compatibility (EMC) immunity	EN 61000-6-2
Electromagnetic Compatibility (EMC) emissions	EN 55011:2016 Class A
Performance	IEC 62040-3, VFD SX 211 ≤ 450 kVA VFD SS 211 > 450 kVA

5 SUBASSEMBLIES

The PCS100 UPS-I consists of the following subassemblies:

- A Utility Disconnect that disconnects the utility supply during a disturbance
- Inverters that convert energy storage DC energy to 3-phase AC power
- Float Charger to charge the energy storage when the utility is operating normally
- A Fail-Safe Bypass to automatically bypass the PCS100 UPS-I when a fault occurs.
  Note: The Fail-Safe Bypass is optional in some models.
- A Coupling Transformer to match the inverter output with the nominal utility voltage.
  Note: There are two Coupling Transformers for 3 MVA systems.
- Energy Storage (Ultracapacitor or battery) that supplies power to the load during a utility disturbance

Together, these sub-assemblies are referred to as the PCS100 UPS-I system. Small PCS100 UPS-I models have multiple sub-assemblies in one enclosure. Large PCS100 UPS-I models may have one sub-assembly housed in multiple enclosures.

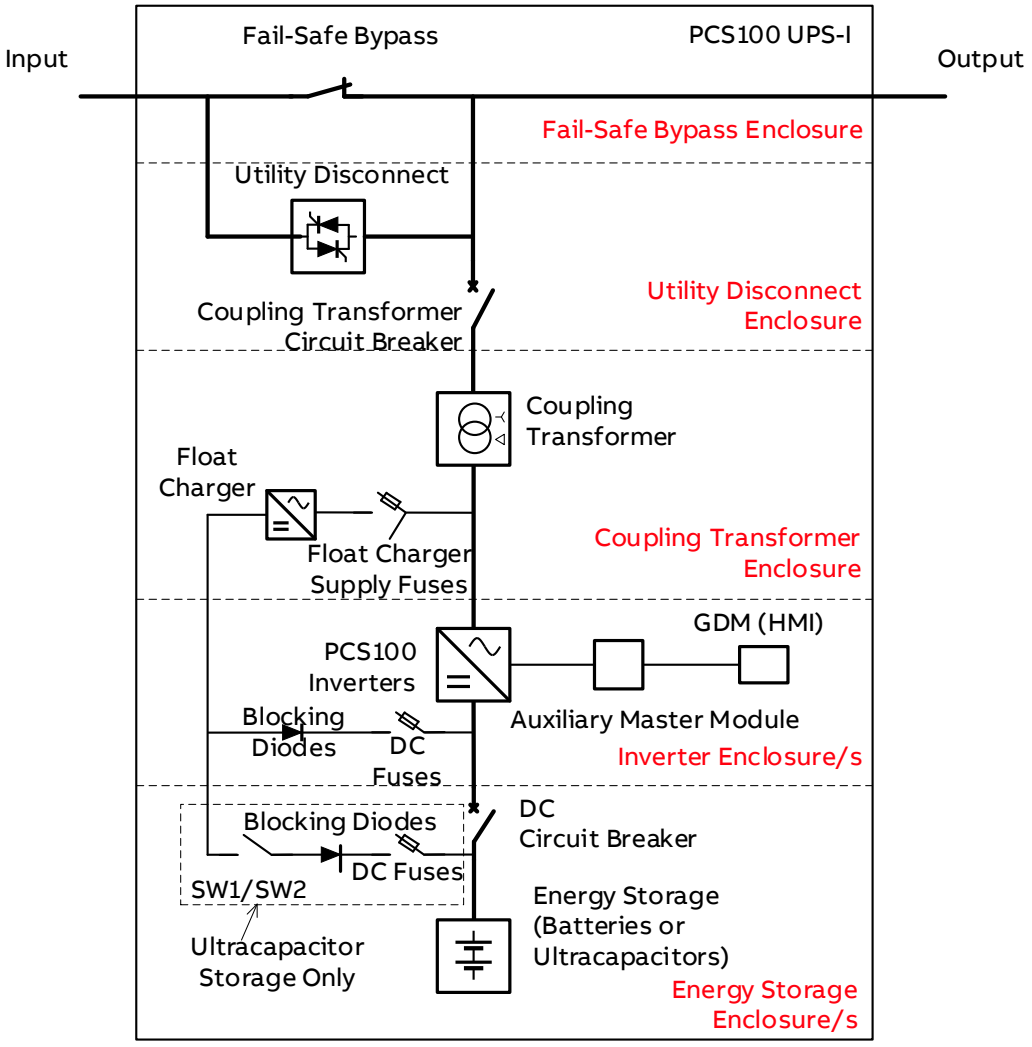


Figure 5-1: PCS100 UPS-I SLD with enclosure definition

These sub-assemblies are described in the following sections.

5.1 Utility Disconnect

The Utility Disconnect is an electronic switch that is used to rapidly disconnect the utility supply from the load if the utility supply falls out of tolerance.
The Utility Disconnect consists of a naturally commutated SCR based electronic switch augmented with ABB's revolutionary inverter commutation capability which can disconnect the load from the utility in typically 1.8 ms.
When the utility voltage is within specification the Utility Disconnect is closed and the load is supplied from the utility. This is known as 'Online" mode. When the utility voltage is outside specification, the Utility Disconnect is opened, disconnecting the utility from the load. The load is then supplied by the inverter from the energy storage.
There are three sizes of Utility Disconnect. These are:

- 900 A
- 2200 A
- 4200 A

The type of Utility Disconnect used on a particular model varies depending on the PCS100 UPS-I current rating. See Table 3-2: PCS100 UPS-I model range.

PCS100 UPS-I	**Utility Disconnect Rating (A)**			
Rated Power (kVA)	**480 V**	**440 V**	**400 V**	**220 V**
150	900		900	900
300	900		900	900
450	900		900	2200
600	900		900	2200
750	900		2200	2200
900	2200		2200	4200
1200	2200		2200	4200
1500	2200		2200	4200
1800	2200		4200	
2100	4200		4200	
2400	4200		4200	
3000		4200		

5.1.1 900 A Utility Disconnect

The 900 A Utility Disconnect is module based and it is installed in the Inverter Enclosure.
The 900 A Utility Disconnect incorporates redundancy in the form of integrated normally closed Fail-Safe Bypass contactors that close when the PCS100 UPS-I is turned off or there is a fault.
The Utility Disconnect cooling fans run continuously.
Cooling air flow is from front to back.

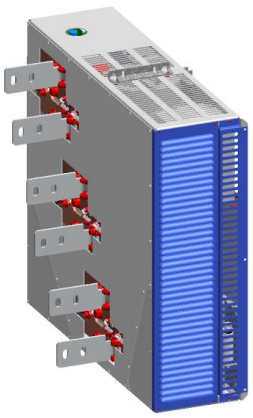


Figure 5-2: 900 A Utility Disconnect module

5.1.2 2200 A and 4200 A Utility Disconnect

The 2200 A and 4200 A Utility Disconnect are separate enclosures that also include the main input and output terminals for connecting the PCS100 UPS-I to the utility and the load.

DANGER – Hazardous Voltages
An Operator must not open doors or panels marked as containing hazardous voltages. Many parts in this product, including printed circuit boards operate at lethal voltages. DO NOT TOUCH components or connections that have voltage present

DANGER – Arc Flash
Shorted terminals can cause arc flash resulting in severe burns, severe eye injury, blindness or death. Use insulated tools and do not short any terminals. Wear appropriate personal protective equipment.

The Coupling Transformer circuit breaker is also housed in the Utility Disconnect enclosure. It provides short circuit and current imbalance protection for the coupling transformer and over voltage protection for the inverters and energy storage.

The Utility Disconnect cooling fans run continuously.
Air intake is from front of the cabinet.
Air exhaust is through the top of the cabinet.

The front half of the Utility Disconnect Enclosure is pressurized which forces air through the SCR heat sinks and out the top of the enclosure.
The Utility Disconnect Enclosure includes internal pressure monitoring. Reduced air pressure, will result in a warning on GDM (or Modbus/TCP).

Reduced pressure on UD will be result of:

- Fan failure
- Dirty air filters
- Opened UD enclosure doors

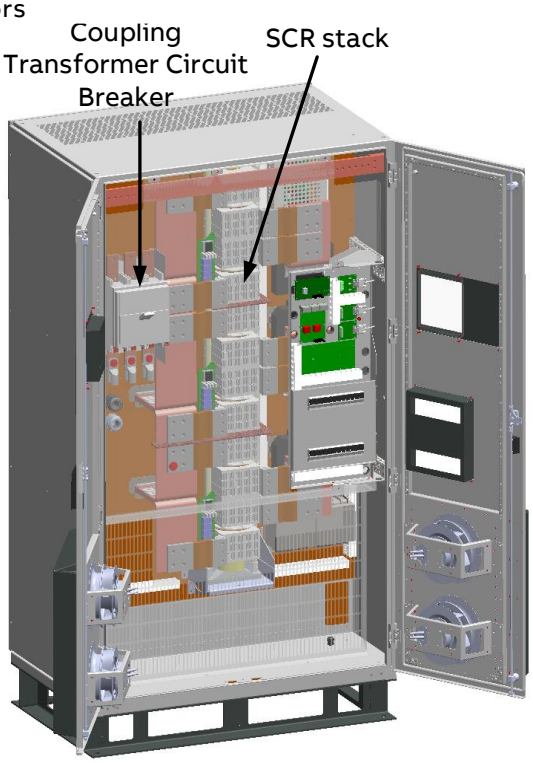


Figure 5-3: 2200 A and 4200 A Utility Disconnect Enclosure

The main visual difference of the Utility Disconnect MkII is the addition of the cooling fans in the front doors. The MkI Utility Disconnect has the cooling fans in the bottom.

5.1.3 Coupling Transformer Enclosure

The Coupling Transformer Enclosure houses:

- Coupling Transformer
- Float Charger
- And various small protection and measuring devices.

DANGER – Hazardous Voltages
An Operator must not open doors or panels marked as containing hazardous voltages. Many parts in this product, including printed circuit boards operate at lethal voltages. DO NOT TOUCH components or connections that have voltage present

Figure 5-4: Coupling Transformer Enclosure

5.1.4 Coupling Transformer

The Coupling Transformer consists of delta connected primary and star connected secondary.
In the event of an outage the inverter supplies approximately 428 Vac to the primary and the secondary is connected to the load.
The coupling transformer has 3 main purposes:

- Transforms inverter output voltage to match the utility voltage,
- Transforms the 3-wire inverter voltage (U, V and W) into a 4-wire voltage (L1, L2, L3, & N),
- Isolation of the inverter common mode voltages from the utility.

CAUTION
The star point of the coupling transformer must be connected to the supply neutral. The star point is the neutral reference while the PCS100 UPS-I inverter is discharging.

5.1.5 Float Charger

While the inverters provide a fast replenishment of energy following a power quality event, a dedicated Float Charger is used for float charging to optimize energy efficiency. The Float Charger also allows Ultracapacitor based systems to start from a completely discharged state.

Note:
For the smallest PCS100 UPS-I systems without a separate Coupling Transformer Enclosure (frame size 1xB) the Float Charger is installed in the Termination Enclosure.

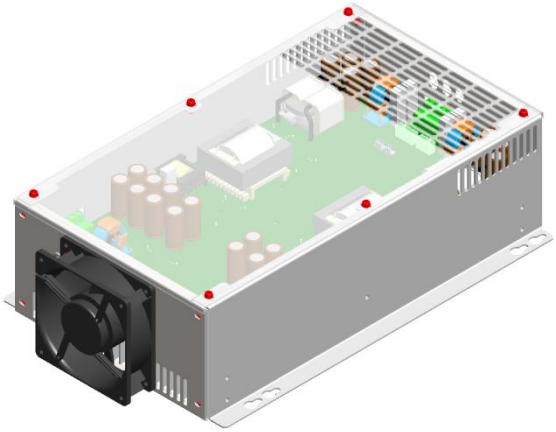


Figure 5-5: Float Charger

5.1.6 Inverter Enclosure

One Inverter Enclosure can hold up to six PCS100 Inverter modules. Where the PCS100 UPS-I requires more than six inverters, two or more enclosures will be required. One enclosure is deemed the Master Inverter Enclosure and the remaining are deemed Slave Inverter Enclosures.
The Master Inverter Enclosure also houses the Master Auxiliary Module.
The Graphical Display Module (GDM) is always mounted in the door of the master Inverter enclosure.
The Slave Inverter Enclosure houses a Slave Auxiliary Module.

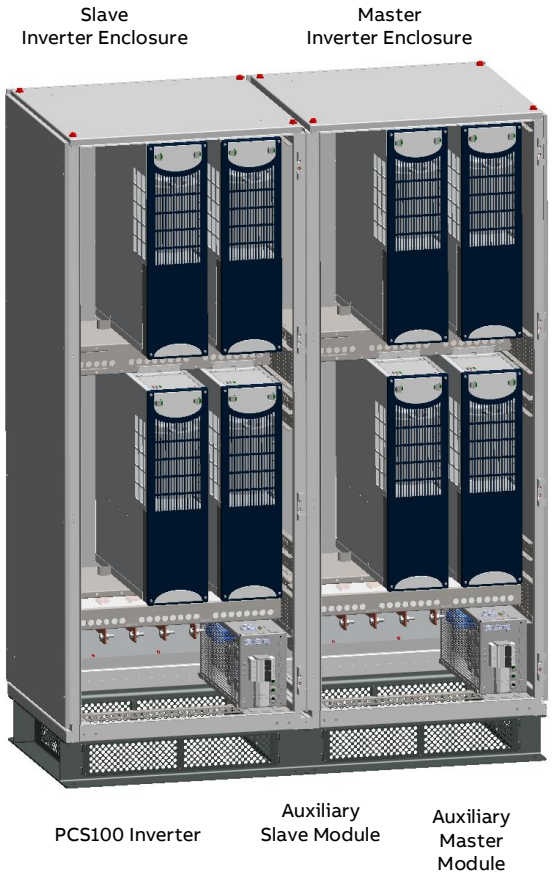


Figure 5-6: Inverter Enclosures

DANGER – Hazardous Voltages
An Operator must not open doors or panels marked as containing hazardous voltages. Many parts in this product, including printed circuit boards operate at lethal voltages. DO NOT TOUCH components or connections that have voltage present

5.1.7 PCS100 Inverter

The PCS100 Inverter modules are IGBT based power electronics modules rated at 150 kVA.
The inverters include a sine filter as part of the assembly, meaning the power electronics and sine filter are integrated into one module.

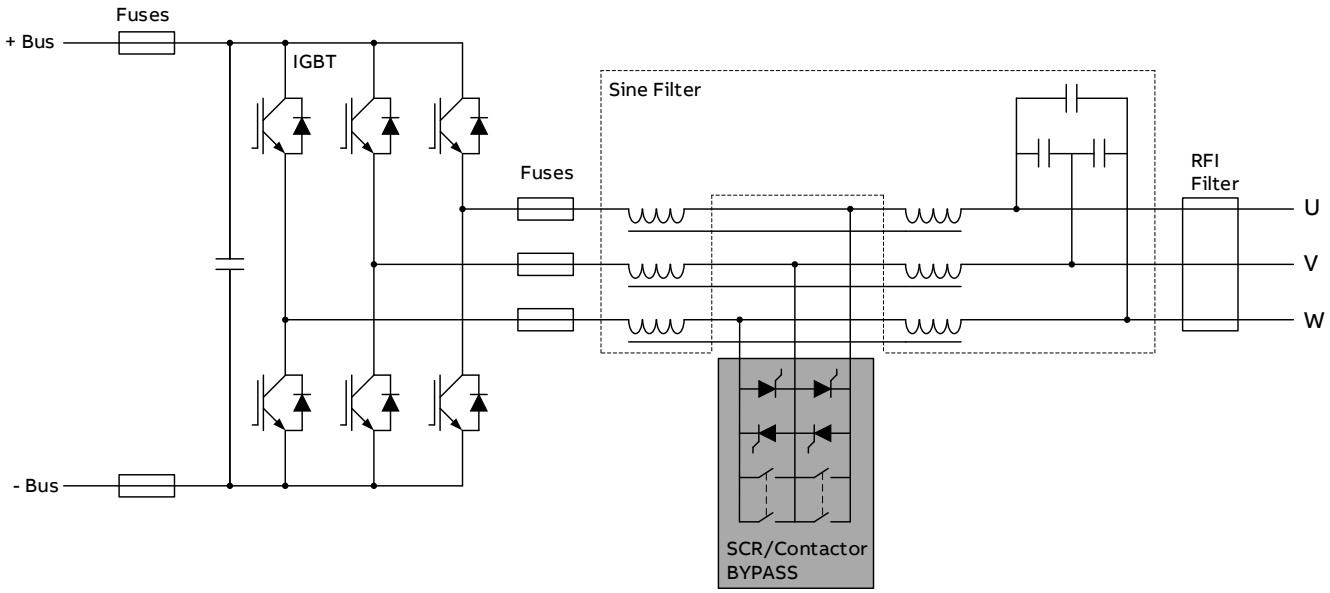


Figure 5-7: PCS100 UPS-I inverter diagram

Figure 5-8: PCS100 Inverter

In addition to converting DC storage voltage to AC voltage required by the load, the inverters quickly re-charge the energy storage (fast charging) after a power quality event.

Depending on the required power, between one and twenty ABB PCS100 inverters are used.

Each inverter module has a unique identification number (1 - 32) which is displayed on the front of the module.
The inverter cooling fans are switched off most of the time. They switch on when the PCS100 UPS-I is discharging and remain switched on for about 30 seconds afterwards.
The cooling air flow is 9 m^3/min per inverter module.

Advanced Redundancy

The PCS100 UPS-I inverter consists of multiple 150 kVA PCS100 Inverter modules connected in parallel. If one module fails the PCS100 UPS-I will automatically reconfigure during stand-by or while supporting the load to operate with the remaining modules.
For example, a six inverter PCS100 UPS-I system offers 900 kVA for normal load protection. If one module fails, the maximum system capacity will be reduced to 750 kVA, and the PCS100 UPS-I GDM (HMI) will indicate system availability of 83%.
A maximum of 50% of the modules can fail before the PCS100 UPS-I will trip out.

5.1.8 Auxiliary Master Module

The Auxiliary Master Module controls the overall system operation from a central point. It controls all inverters and coordinates the actions of the Utility Disconnect and the Fail-Safe Bypass. It also provides communication functionality to the PCS100 UPS-I's GDM and external serial networks.

Additionally, the Auxiliary Master Module includes:

- A 26.5Vdc auxiliary power supply for the control electronics.
- A 230Vac auxiliary power supply for the inverter module fans. Auxiliary power supply protection and distribution for up to 6 inverter modules.
- IO module for external control and monitoring purposes.

Control and monitoring wiring is explained in Section 13.2.

Figure 5-9: Auxiliary Master Module

5.1.9 Auxiliary Slave Module

The Auxiliary Slave Module is the same as the Auxiliary Master Module except it does not contain the control logic or associated PCBs and I/O terminals. It contains just the auxiliary power supplies, protection and distribution to the slave inverter enclosure for up to six inverter modules. One Auxiliary Slave is required per slave inverter enclosure. Note the 26.5 Vdc supplies developed by each Auxiliary Module are not commoned between enclosures.

5.1.10 Fail-Safe Bypass

The Fail-Safe Bypass provides an additional level of security by providing an alternative current path in the event of an expected or unexpected PCS100 UPS-I shutdown.
The Fail-Safe Bypass is a highly automated and coordinated option which provides a degree of extra security against a PCS100 UPS-I failure.

Note: The ABB Fail-Safe Bypass does not isolate the PCS100 UPS-I for maintenance or service works.
ABB recommend installation of a maintenance bypass for this purpose.

5.1.11 Intergrated Fail-Safe Bypass

The PCS100 UPS-I with 900 A Utility Disconnect have an integrated Fail-Safe Bypass inside the Utility Disconnect module in the form of normally closed contactors.

5.1.12 Optional Fail-Safe Bypass

For a PCS100 UPS-I with a Utility Disconnect rated at 2200 A or 4200 A, the Fail-Safe Bypass is optional and supplied in own enclosure.
If a Fail-Safe Bypass is fitted, the main utility and load terminals are contained within the Fail-Safe Bypass enclosure.
If the PCS100 UPS-I system is fitted with optional Fail-Safe Bypass the type code of the unit includes +FSx where x is:

- 2 for system with 2200 A Utility Disconnect
- 4 for system with 4200 A Utility Disconnect

The main switching element of the Fail-Safe Bypass consists of an ABB Emax switch-disconnector.

The ABB Emax switch-disconnectors are derived from the corresponding ABB Emax air circuit-breaker. The switch-disconnector differs only by of the absence of the protection trip units.

Figure 5-10: 2200 A and 4200 A Fail-Safe Bypass Enclosure

The PCS100 UPS-I controller closes the switch-disconnector via an integral remote trip coil.

Capacitors in the Utility Disconnect contain enough energy to operate the trip coil in the event of a LVDC power supply failure. An auxiliary relay provides feedback to the PCS100 UPS-I controller indicating whether the FSB is open or closed.

The energy required to open or close the switch-disconnector is supplied via an internal spring which is charged by an integrated motor. The PCS100 UPS-I will not attempt to open the FSB unless the ACB closing spring is charged. This ensures that the FSB can re-close immediately whenever required.

A 2200 A or 4200 A PCS100 UPS-I can be applied without a Fail-Safe Bypass, However the Fail-Safe Bypass provides increased security in the unlikely event of a Utility Disconnect fault such as an SCR over-temperature or a low volts DC power supply failure.

If a 2200 A or 4200 A Fail-Safe Bypass is fitted, the main input and output terminals for connecting the PCS100 UPS-I to the utility and the load are contained on the right hand side of the Fail-Safe Bypass enclosure.

6 ENERGY STORAGE

The PCS100 UPS-I systems supplied by ABB include one of the following energy storage systems:
- Ultracapacitors or
- Valve-regulated lead-acid (VRLA) batteries.

Ultracapacitor Energy Storage (ECxx in PCS100 UPS-I model code) is ideal for protecting the load from frequent sags, swells and short-term outages or to bridge the switching time to another feeder.

Battery Energy Storage (EBxx in PCS100 UPS-I model code) is typically used to bridge start-up time for generator backup systems where critical applications may be subject to longer supply outages.

The amount of energy storage required depends on the load kW rating, and autonomy period (seconds). The autonomy period is the period of time the PCS100 UPS-I can supply rated load from its energy storage. The required number of enclosures increases with the PCS100 UPS-I rating and autonomy period. Each energy storage enclosure includes its own DC circuit protection.

6.1 Ultracapacitor Energy Storage

Ultracapacitor Energy Storage consists of one or more 300 kW Ultracapacitor strings. One 300 kW string consists of multiple Ultracapacitor modules connected in series to a voltage of 750 VDC. Multiple strings are connected in parallel for increased kW or autonomy (ride through) time. The autonomy time is typically 2 to 3 seconds at rated kVA and 0.8 PF when the Ultracapacitors are new. Some models have different autonomy due to storage medium rationalization. One Ultracapacitor enclosure can contain 1 or 2 Ultracapacitor strings. Each string is protected by its own main DC circuit breaker and separate charger fuses.

The number of the series connected Ultracapacitor modules in single Ultracapacitor string depends on which Ultracapacitor module type is used..
ABB Ultracapacitor Energy Storage module types available are:

Producer	Voltage	Modules per string	Module Overvoltage monitoring	Module Over c monitoring
LS Materials	46.9 V	16	Yes	Yes

Table 6-1: Ultracapacitor module types overview

ULTRACAPACITOR ENERGY STORAGE FEATURES:
- Single string maximum rating is 300 kW for 2 seconds when the Ultracapacitors are new
- Multiple Ultracapacitors are connected in series to form a 750 VDC string (+/- 375VDC)
- 1 or 2 strings per enclosure, each individually protected
- Design life: 15 years @ 25º C
- Very high cycle life: >500,000
- High discharge efficiency
- Ultracapacitor module balancing
- Extensive monitoring and protection
- Safe and compact matching enclosure
- Very low maintenance
- Very small footprint

DANGER – Stored Charge
Stored charge is present after the device is switched off. When the PCS100 UPS-I is powered down lethal voltages (+/- 375 Vdc) will remain in the energy storage element and the complete PCS100 UPS-I should be considered live.

DANGER – Potential Material Hazard of Batteries and Ultracapacitors
Under normal operation batteries and Ultracapacitors do not pose a risk to safety, however incorrect operating or handing, or physical damage could result in hazardous conditions. See the links and QR codes in this User Manual to the appropriate Material Safety Data Sheets.

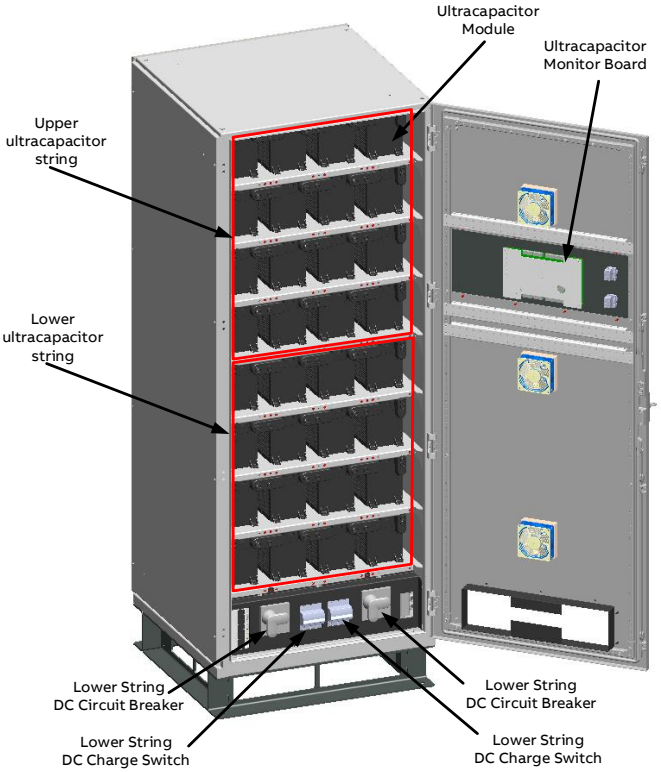


Figure 6-1: Ultracapacitor Energy Storage Enclosure with LS Mtron Ultracapacitor modules

NOTE: For safety information about the Ultracapacitor modules please see the Manufacturers Material Safety Data Sheets.
Cut and paste these links into an Internet browser, or scan the QR codes.

LS Mtron Ultracapacitors

	http://search.abb.com/library/Download.aspx?DocumentID=9AKK107046A3621&LanguageCode=en&DocumentPartId=&Action=Launch

6.1.1 Utracapacitor Monitor Board

Each Ultracapacitor Energy Storage Enclosure (CESE) includes Ultracapacitor Monitor Board that is monitoring all relevant information inside the enclosure:

- Status of all Ultracapacitors per string (overvoltage and overtemperature)
- Incoming DC voltage
- DC voltage of each Ultracapacitor string
- DC circuit breaker status
- Enclosure internal temperature

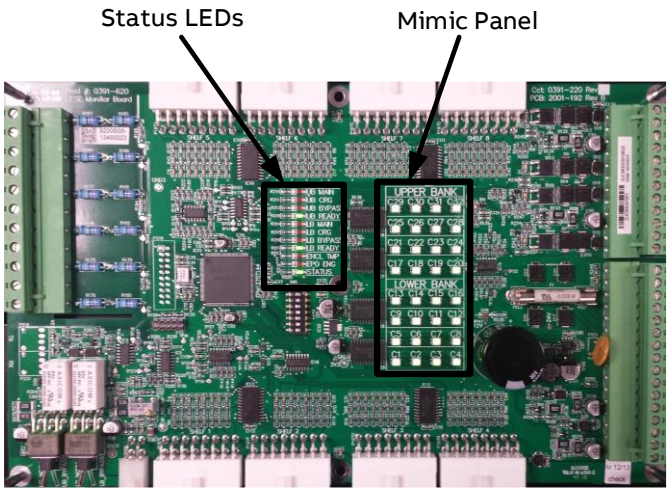


Figure 6-2: Ultracapacitor Monitor Board

In case of a fault in any of the Ultracapacitor module or enclosure the Ultracapacitor Monitor Board automatically takes the appropriate action which may be a warning or if necessary isolate the string with a faulty module. Non-faulty string operation is not influenced. In any event a warning is issued on the PCS100 UPS-I GDM and service personnel can determine the cause of the warning from inspection of the Monitoring Board.

The Ultracapacitor Monitor Board includes two levels of HMI for information.

- Two Status/Reset lamps on the front door for general information on status of each string
- Mimic panel and Status LEDs on the Ultracapacitor Monitor Board inside the enclosure give additional information on status of each Ultracapacitor module and complete Energy Storage Enclosure.

6.1.2 Ultracapacitor Energy Storage User Interface

The Ultracapacitor Monitor Board is primarily used to monitor fault outputs from each Ultracapacitor module in an enclosure. Two types of faults can be monitored per Ultracapacitor module; overvoltage and overtemperature.
If any of these faults occur, the appropriate breakers are tripped and the string is disengaged from the system and the fault is communicated to the user.

The enclosure temperature is monitored to warn the user of exceeding the recommended operating temperature, and for tripping the breakers if the temperature indicates a major failure i.e. over 67 ºC implying a large amount of heat is being generated (in particular the possibility of a fire).

String voltage vs. DC bus voltage is monitored to prevent breakers being closed when voltage difference is greater than 30 V, and to indicate when it is safe to close them.

The design approach is that tripping the breakers is to be avoided wherever possible. So if faulty inputs are detected, a warning is generated and they are rendered unprotected in preference to taking the system off-line.

Faults and warnings are communicated to the user in three ways, in increasing levels of information.

1. **Fault/Warning Digital Output:**

A relay contact output which informs the downstream master that there is a warning or fault in one of the enclosure in the system, i.e. requiring investigation.
The PCS100 UPS-I GDM displays warning

2. **Status Lamps:**
   External door lamps identify the enclosure and/or string in question. They convey the type of warning or fault that has occurred by means of flash sequences.

3. **Internal Mimic Panel and Status LEDs:**
   The Mimic Panel represents the capacitors fault outs. It identifies the capacitor/(s) causing the warning or fault and indicates the fault type with the number of red flashes.
   Additional Status LEDs indicate any other warning or fault (EPO, enclosure overtemperature, supply status, etc.)

Reset of upper or lower string fault/warnings is by means of a 3 second press to external reset buttons (integrated in the Status Lamps).

6.1.2.1 Status Lamps

Each Ultracapacitor Energy Storage Enclosure has two external door Status Lamps.
Each Status Lamp represents one of two Ultracapacitor strings in single enclosure.

Status Lamp convey the type of warning or fault that has occurred by means of flash sequences.

Table 6-2: Status Lamps states description shows Status Lamp states.

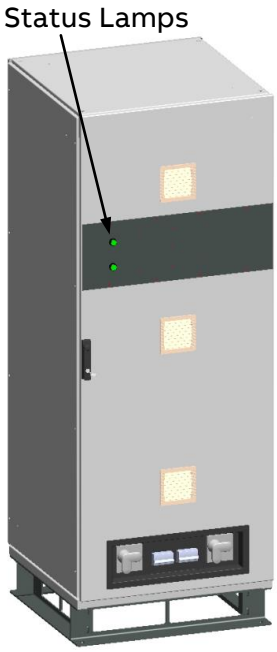


Figure 6-3: Ultracapacitor Energy Storage Enclosure

Status Lamp State	Cause	Recommended Action
3 quick flashes	Ultracapacitor module fault Enclosure temperature > 67 ºC EPO engaged	1) Identify fault using LEDs on Ultracapacitor Monitor Board.
2 quick flashes	String DC circuit breaker is off, string and inverter DC bus voltages are not equalized.	1) Check DC charge switch (SW1 or SW2) is closed. 2) The UPS-I must be turned on (On Line) 2) Wait until 1 quick flash
1 quick flash	String DC circuit breaker is off, string and inverter DC bus voltages are equalized and no fault present	1) Connect the string to the system by switching the string DC circuit breaker on.

1 sec on/off	Internal connection fault, Ultracapacitor Monitor Board fault, Fault bypass is on	1) Identify fault using LEDs on Ultracapacitor Monitor Board
90% on, 10% off	Enclosure temperature is exceeding recommended operating temperature	1) Record temperature details for future reference 2) Check enclosure fans 3) Reset appropriate string 4) If problem is still present check the electrical room air conditioning/ventilation status
On	OK	
Off	Ultracapacitor Monitor Board is not powered	1) Check fan supply voltage. If not 24V replace fuse and/or Ultracapacitor Monitor Board

Table 6-2: Status Lamps states description

6.1.2.2 Mimic Panel

The Ultracapacitor module's overvoltage and overtemperature inputs are connected to the Ultracapacitor Monitor Board in groups of 4, representing 1 shelf in the enclosure. The upper and lower strings are separated on the board and are managed as separate entities, i.e. a faulted upper string Ultracapacitor module will only trip the upper string DC circuit breaker and DC charge switch.

The Mimic Panel represents the status of each Ultracapacitor module in the enclosure, as they are laid out in the cabinet. Ultracapacitor Monitor Board logic is able to distinguish between a disconnected sensor and a sensible input range. The aim of this functionality is to prevent any false trips caused by faulty connections or wiring faults. A warning is given if these are detected and these inputs are rendered unprotected i.e. do not have any influence on the breaker trips. If the LED is solid green then the capacitor and connection are OK, if not the LED will be flashing red a number of times, indexing the fault or warning condition.

The statuses are described in Table 6-3. They are in order of priority highest to lowest. For example an overtemperature condition will mask an overvoltage condition as it is a more severe problem.

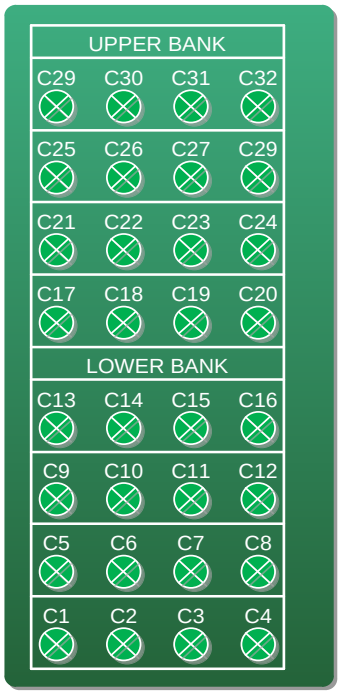


Table 6-3: Ultracapacitor Monitor Board Mimic Panel

No. of flashes	LED Color	Ultracapacitor Module State	Cause	Recommended Action
1	Red	Over temperature	Faulty Ultracapacitor module	Replace Ultracapacitor module
2	Red	Overvoltage	Faulty Ultracapacitor module	Replace Ultracapacitor module
3	Red	PTC Not Connected	Not connected	Check PTC wiring to Ultracapacitor module
4	Red	Voltage Sensing Connection Fault	Reverse connection, Not connected	Check voltage sensing wiring to Ultracapacitor module

5	Red	Over temperature Error	Comparator output impossible, circuit fault	Replace Ultracapacitor Monitor Board
6	Red	Overvoltage Error	Comparator output impossible, circuit fault	Replace Ultracapacitor Monitor Board
Solid	Green	OK		

Table 6-4: Ultracapacitor Monitor Board Mimic Panel description

Each warning state is 'latched' so if a problem is intermittent, the warning will stay present until acknowledged by a reset. If the fault or warning status still exists at the time of reset, then the warning will continue to display its warning status. If the condition has stopped, then the warning will fall to a lower priority warning until it is back to OK.

6.1.2.3 Status LEDs

The Status LEDs give information on the status of different parts of the Ultracapacitor Energy Storage Enclosure and Ultracapacitor Monitor Board.

A description of each LED are described in Table 6-5.

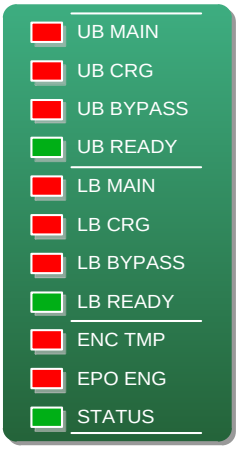


Figure 6-4: Ultracapacitor Monitor Board Status LEDs

Status LED	Status	Description	Recommended Action
UB MAIN	On	UB string DC circuit breaker is in tripped state	Resolve tripping condition
UB CRG	On	UB string DC charge switch is in tripped state	Resolve tripping condition
UB BYPASS	On	UB string fault bypass switch activated	Is the string meant to be decommissioned? If not return to 'Normal'
UB READY	On	UB string DC voltage is within +/-30 V from PCS100 UPS-I DC bus voltage	Safe to close string DC circuit breaker
	Off	UB string DC voltage not within +/-30 V from PCS100 UPS-I DC bus voltage	Wait for string to charge
LB MAIN	On	LB string DC circuit breaker is in tripped state	Resolve tripping condition
LB CRG	On	LB string DC charge switch is in tripped state	Resolve tripping condition
LB BYPASS	On	LB string fault bypass switch activated	Is the string meant to be decommissioned?

			If not return to 'Normal'
LB READY	On	LB string DC voltage is within +/-30 V from PCS100 UPS-I DC bus voltage	Safe to close string DC circuit breaker
	Off	LB string DC voltage not within +/-30 V from PCS100 UPS-I DC bus voltage	Wait for string to charge
ENC TEMP	Off	Operating in recommended temperature range < 28 ºC	
	1 second on/off	Operating over recommended temperature range > 28 ºC	Reset with either Status Lamp button, if condition still persists adjust air con down and retry
	On	Exceeding trip temperature of 67 ºC All circuit breakers tripped	Decommission and service Ultracapacitor Energy Storage Enclosure
	2 quick flashes	Temperature sensor not connected	Check connection of temperature sensor. if OK replace temperature sensor and reset
EPO ENG	On	Emergency Power Off (EPO) override has been activated	Hold any Status Lamp button for 3 seconds to reset
STATUS	On	OK	
	1 quick flash	24 V supply voltage out of limits	Check AC supply of enclosure. If OK replace Ultracapacitor Monitor Board
	2 quick flashes	5 V supply voltage out of limits	Check AC supply of enclosure. If OK replace Ultracapacitor Monitor Board
	3 quick flashes	3.3 V supply voltage out of limits	Check AC supply of enclosure. If OK replace Ultracapacitor Monitor Board

Table 6-5: Ultracapacitor Monitor Board Status LEDs description

6.1.3 Ultracapacitor Energy Storage Autonomy Time

Ultracapacitor Energy Storage consists of one or more 300 kW Ultracapacitor strings. Multiple strings are connected in parallel for increased kW or autonomy (ride through) time.
Based on the system rating PCS100 UPS-I systems offer autonomy according to Table 6-6.

PCS100 UPS-I Rated Power (kVA)	**Ultracapacitor Energy Storage**		**Autonomy time (s)**		**Frame Size**	**Type Code**
	No. of Strings	Power Rating (kW)	0.8 PF	1.0 PF		
150	1	300	8	6.5	1xA	EC01
300	1	300	3	2	1xA	EC01
450	2	600	5	3.5	1xA	EC02
600	2	600	3	2	1xA	EC02

750	2	600	2	-	1xA	EC02
750	3	900	4	3	2xA	EC03
900	3	900	3	2	2xA	EC03
1200	4	1200	3	2	2xA	EC04
1500	4	1200	2	-	2xA	EC04
1500	5	1500	3	2	3xA	EC05
1800	5	1500	2.2	-	3xA	EC05
1800	6	1800	3	2	3xA	EC06
2100	6	1800	2.3	-	3xA	EC06
2100	7	2100	3	2	4xA	EC07
2400	7	2100	2.5	-	4xA	EC07
2400	8	2400	3	2	4xA	EC08
2400	8	2400	2	-	4xA	EC08
3000	10	3000	-	2	5xA	EC10

Table 6-6: PCS100 UPS-I Ultracapacitor Energy Storage specifications

The Storage Load vs. Autonomy Period graph below shows dependency of autonomy period versus loading of Ultracapacitor Energy Storage on ambient temperatures on 25 ºC and below.

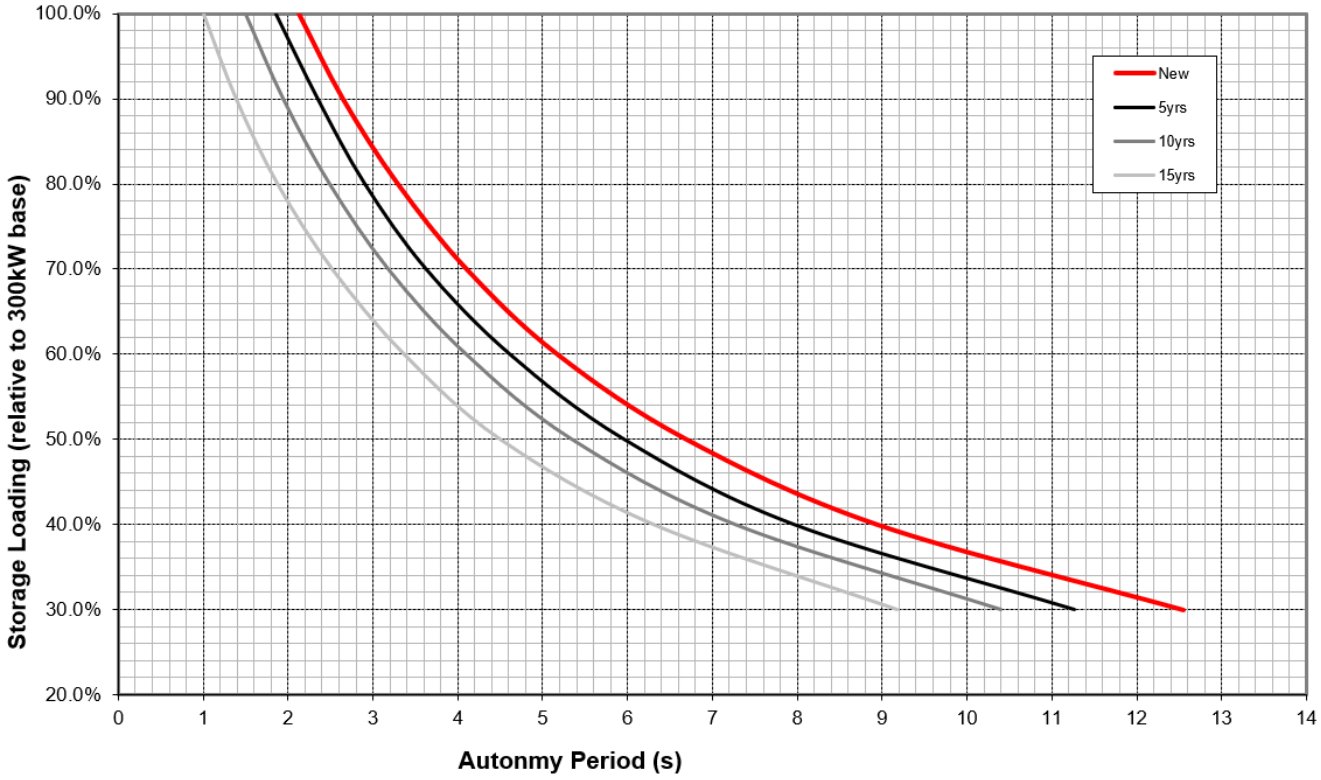


Figure 6-5: Storage Load vs. Autonomy Period Graph

Care should be taken to ensure the Ultracapacitor Energy Storage enclosure temperature does not exceed 25 ºC. The life expectancy of the capacitors reduces significantly above 25 ºC.

The Design Life vs. Operating Temperature graph below shows dependency of Ultracapacitor lifetime versus operating temperature.

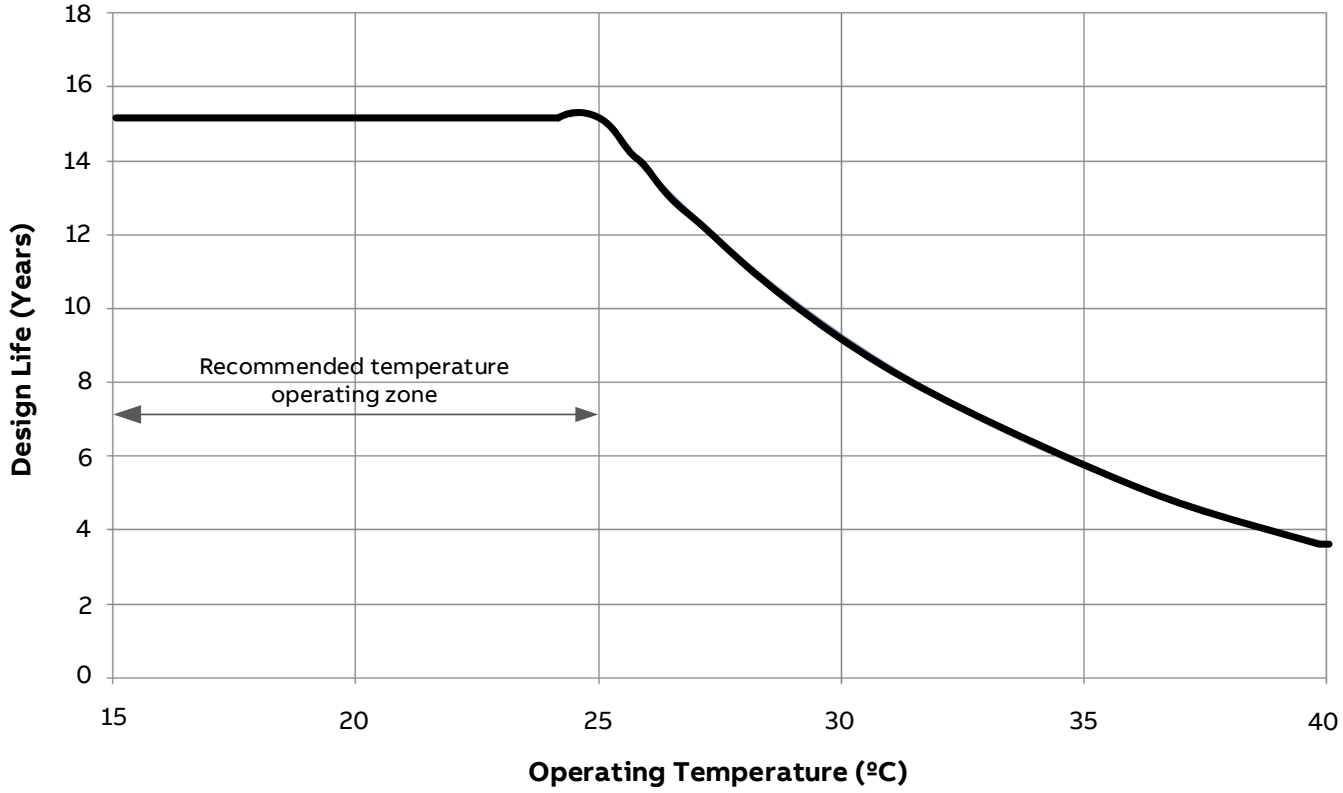


Figure 6-6: Design Life vs. Operating Temperature graph

6.1.4 Calculation of Autonomy Time

The autonomy period for a load level other than those given in the tables can be calculated using the following information and graphs.

Example:

Application's requirements	
Load	500 kVA
Power Factor	0.9
Supply	400 V, 50 Hz
Storage autonomy	Short time autonomy

To use the Storage Loading vs. Autonomy Period graph below the Relative Loading (%) of the energy storage must be calculated.

1. **PCS100 UPS-I model selection**
   Based on application load requirements and PCS100 UPS-I Ultracapacitor model tables, the closest larger kVA rating PCS100 UPS-I model can be selected.

Rated power kVA @ 400 V	**Rated power** kVA @ 380 V	**Autonomy time** Sec (Rated kVA @ 0.8PF)	**Autonomy time** Sec (Rated kVA @ 1.0PF)	**Inverter Rated Current [**A]	**Inverters [**Quantity]	**Utility Disconnect Rated Current**	**Terminal Position** (Utility &	**Losses [**kW (typical)]	**Efficiency** [% (typical)]	**Airflow [**(m^3/min) Standby]	**Fault Capacity** (Icw) kA / **Withstand Period** ms	**Frame Size**		**Type Code**
												PCS100 UPS-I	**Energy Storage**	
600	570	3	2	866	4	900	L	5.9	99.0	27	25 / 10	1xB 1xC	1xA	PCS100-12-400/50-04-L-EC02

2. **Application active load calculation**
   First it is necessary to determine the kW rating of the load.
   Either take the load kW if known, or multiply the load kVA by the Power Factor to determine the Load kW.

Load kW calculation		
Load kW	500 kVA x 0.9	450 kW

3. **Energy storage rating determination**
   In this step it is necessary to determine number of Ultracapacitor strings required.
   Ultracapacitor energy storage is based on the number of parallel connected Ultracapacitor strings as defined in the PCS100 UPS-I Type code (ECxx: where xx defines number of parallel connected Ultracapacitor strings). Storage rating is determined by multiplication of number of strings l by 300 kW.
   In selected model with Type code PCS100-12-400/50-04-L-EC02 there are 2 Ultracapacitor strings.

Energy storage rating		
Energy storage rating	300 kW x 2	600 kW

4. **Relative loading calculation**
   Relative Loading can now be calculated by dividing the Load kW by the Storage Rating.

Relative loading calculation		
Relative loading	450 kW / 600 kW	75%

5. **Autonomy determination**
   The actual autonomy for the selected PCS100 UPS-I model, under the given operating conditions, is being determined from reading the information on Storage Loading vs. Autonomy Period graph.

   For this example, autonomy can now be found by moving across from the calculated relative loading point (75%) on the Y-axis and reading the autonomy period from the intersection with the curves.

Autonomy period at 75% relative loading	
New	3.6 s
After 5 years	3.2 s
After 10 years	2.8 s
After 15 years	2.1 s

6.2 Battery Energy Storage

Battery Energy Storage consists of one or more 240 kW battery strings. A 240 kW string consists of 56 valve-regulated lead-acid (VRLA) batteries connected in series to a voltage of 780 VDC. Multiple strings are connected in parallel for increased kW or autonomy (ride through) time. The autonomy time is typically 30 seconds at rated kVA and 0.8 PF. A single Battery Energy Storage enclosure contains 1 battery string.

DANGER – Stored Charge
Stored charge is present after the device is switched off. When the PCS100 UPS-I is powered down lethal voltages (+/- 375 Vdc) will remain in the energy storage element and the complete PCS100 UPS-I should be considered live.

DANGER – Potential Material Hazard of Batteries and Ultracapacitors
Under normal operation batteries and Ultracapacitors do not pose a risk to safety, however incorrect operating or handing, or physical damage could result in hazardous conditions. See the links and QR codes in this User Manual to the appropriate Material Safety Data Sheets.

BATTERY ENERGY STORAGE FEATURES:

- Valve-regulated lead-acid (VRLA) batteries
- Single string maximum rating 240 kW for 30 seconds when the batteries are new.
- 56 batteries are connected in series to form a 780 VDC string (+/- 390VDC)
- 1 string per enclosure, individually protected
- Design Life: 10 years @ 25º C
- Cycle life: >800
- Very high discharge capability
- Safe and compact matching
- Low maintenance
- Small footprint

Figure 6-7: Battery Energy Storage Enclosure

NOTE: For safety information about the Battery modules please see the Manufacturers Material Safety Data Sheets. Cut and paste this link into an Internet browser or scan the QR code.

	http://search.abb.com/library/Download.aspx?DocumentID=2UCD807006&LanguageCode=en&DocumentPartId=&Action=Launch

6.2.1 Models without Batteries

The PCS100 UPS-I can be supplied from the factory without batteries.

Empty battery enclosures can be ordered to fit ABB specified batteries.

Third-party sourced batteries may be used, however, battery systems must meet ABB's battery performance and protection requirements. For information on these requirements, refer ABB document 2UCD120000E013.

6.2.2 Calculation of Autonomy Period at Specific Load Levels

The autonomy period for battery models at other load levels requires consideration of the relative kVA and kW loading. A full explanation of the calculations needed to determine a battery model autonomy period is given in ABB Document 2UCD120000E018 PCS100 UPS-I and system derating for extended autonomy (30-300 seconds).

Note:
Complete Calculation of Autonomy period at specific load levels, with additional features, is implemented in PCS100 UPS-I Sizing Tool.

7 USER INTERFACE

7.1 Graphic Display Module

The primary user interface for configuration of the PCS100 UPS-I is via the Graphic Display Module (GDM) which is mounted in the door of the master inverter enclosure. It allows local control of the PCS100 UPS-I and shows the system status and provides access to the operating parameters and event history.
The GDM interface consists of several pages; each page has a navigation & control panel and the status bar at the top. The Navigation & Control Panel and the Status Bar are displayed at all times.
The navigation panel consists of buttons allowing page selection and the control panel consists of a Start (I) / Stop (O) / Reset button allowing local control of the product.
The status bar displays the current product status and any warning or fault condition that may be present.

Table 7-1 describes general features of GDM, and Figure 7-1 displays Status page of GDM.

Feature	**GDM**
Display resolution	1024 x 600 pixels
Display size	10.1”
Color Graphic display	yes
Touch Sensitive display	yes
Full descriptions of status and faults	yes
Local Start/Stop Reset Control	yes
Status Display	yes
Parameter adjustment	yes
Number of Event Log records stored	10000
Event log can be downloaded to a PC	yes
Remote Web Pages	yes
Modbus TCP connection	yes

Table 7-1: PCS100 UPS-I GDM features

The GDM screen consists of following parts:

1. Navigation & Control Panel
2. Status Bar
3. Page (selectable)

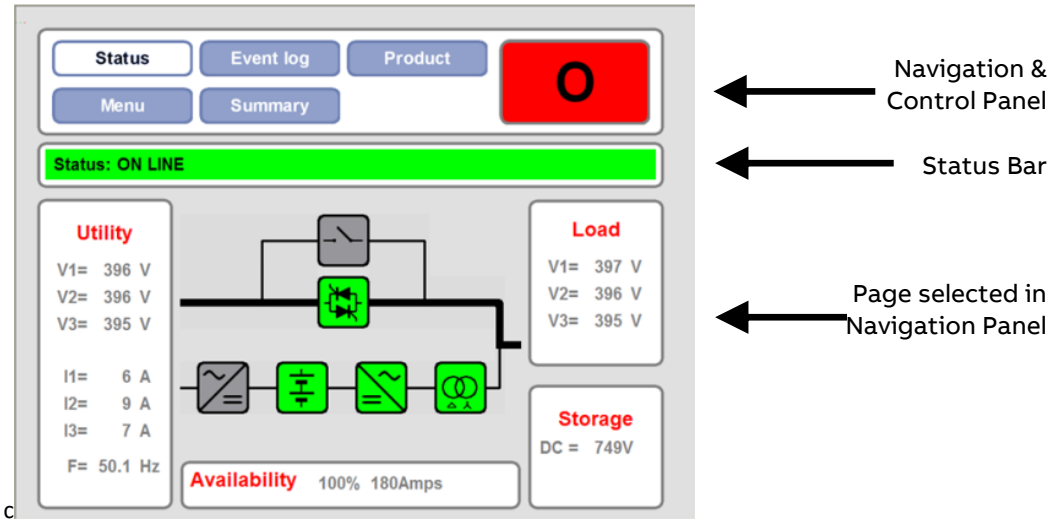


Figure 7-1: PCS100 UPS-I GDM showing the Status page

7.1.1 Navigation Panel

The navigation buttons are displayed at all times.
Press the navigation buttons on the Navigation & Control panel to provide access to the following 5 pages.

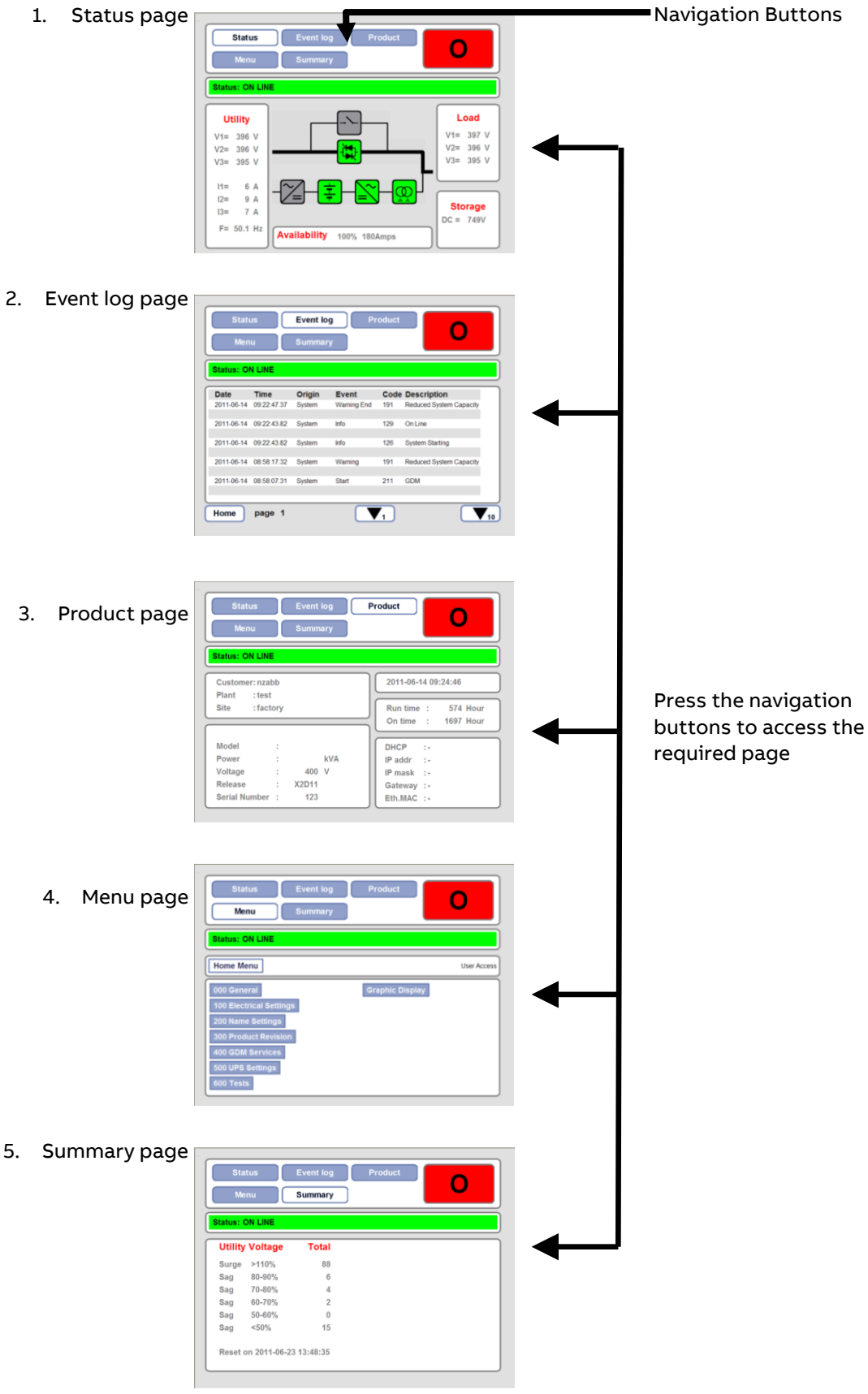


Figure 7-2: PCS100 UPS-I GDM pages

7.1.2 Status Page

The status page shows the input and output voltages, current and frequency. It is the default page after power up.

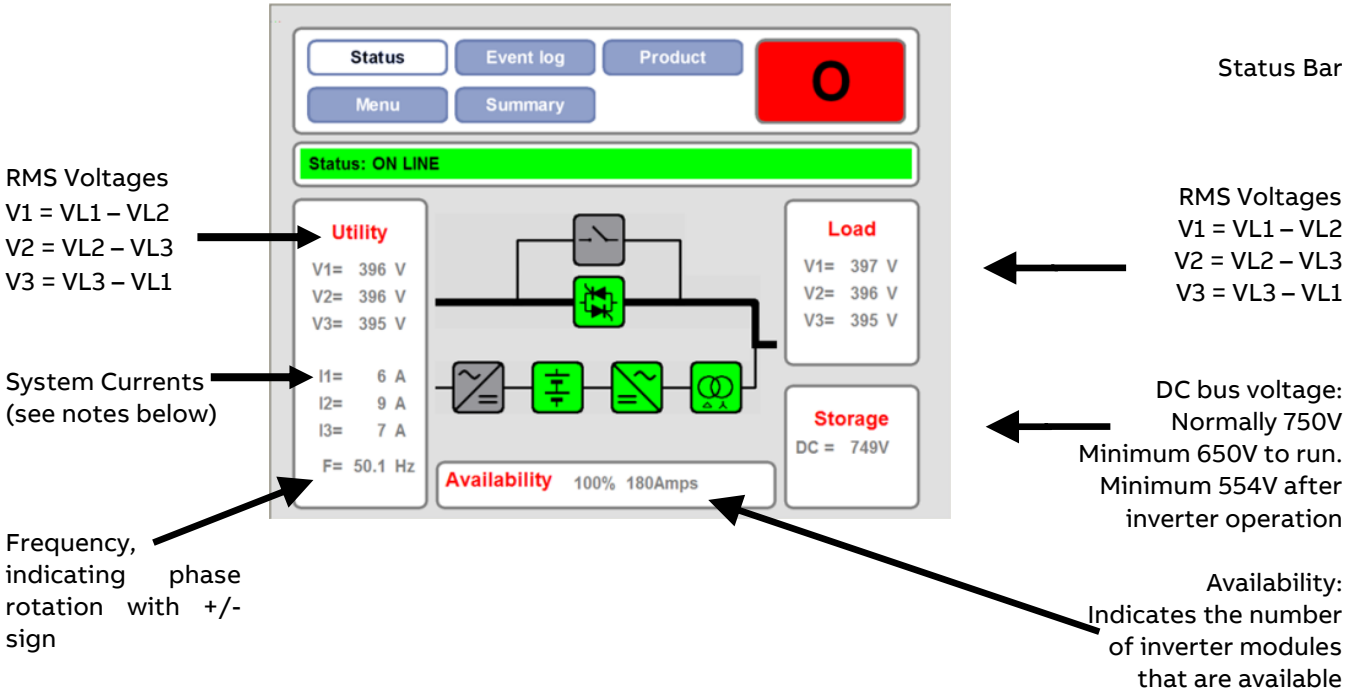


Figure 7-3: GDM Status Page

Note:
When the FSB is closed the current measurement will always be zero. This is because the current transformers are fitted in the Utility Disconnect. When the FSB is closed the FSB provides the least resistance path so all the current will flow through the FSB. For load currents below 1.5% the display snaps to zero.

Note:
At no load the current displayed is the combination of coupling transformer magnetizing current and PWM filter current. This current is mainly capacitive and is generally useful for plants which have a lagging power factor.

The status page of the PCS100 UPS-I in RUN status is shown on Figure 7-3.

The status page of the PCS100 UPS-I in bypass mode is shown on Figure 7-4.

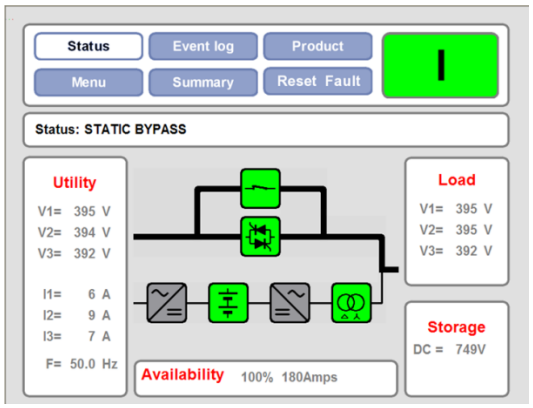


Figure 7-4: PCS100 UPS-I in Static Bypass GDM status Page

The status page icons will change color depending its status.

Status	Icon Color
Run (ON)	Green
Off	Grey
Warning	Yellow
Fault	Red

Table 7-2: GDM Icon color coding

7.1.3 Status Bar

The status bar displays the PCS100 UPS-I status and any warning or fault code (if present).

Figure 7-5: PCS100 UPS-I Status Bar example

1. PCS100 UPS-I Status. Refer to Table 7-4 for a complete list of status messages. See also Figure 7-6
2. Fault or Warning description. The event code number can be found in the event log. Refer to section 11 for complete event descriptions.
3. “Warning” will be displayed if any warning condition exists.

Note:
The Status Bar will only display the most recent event or what is considered the most important event. Touch the Status Bar and a list of all faults and warnings presently active will be displayed.

Color of status bar depends on PCS100 UPS-I status as shown in Table 7-3.

Status Bar Color	**PCS100 UPS-I Status**
Green	Run (Online, Discharging, etc.) with no warning
Green with yellow flashing warning cell	Run (Online, Discharging, etc.) with Warning present
White	Static Bypass
White with yellow flashing warning cell	Static Bypass with Warning present
Red and White flashing	Fault
Yellow	Starting – System Bypassed

Table 7-3: PCS100 UPS-I Status Bar Colors

Figure 7-6 shows the PCS100 UPS-I state flow diagram.

PCS100 UPS-I Status	**Description**
Static bypass	The PCS100 UPS-I is stopped: The Fail-Safe Bypass is closed. (See Figure 7-4)
Booting or system down	The PCS100 UPS-I is booting up or initializing or there is no response from the master this could be due to the GDM CAN cable disconnected.
Fault	The PCS100 UPS-I has tripped, or it is clearing a trip.
Starting – system bypassed	Waiting until the inverters start. The storage DC voltage must be greater than 650VDC, PLL locked, FSB open and the utility voltage within thresholds (parameters 530,531,533 and 535) for the UPS-I to go Online.
On line	Load is operating from the utility supply. The utility voltage and frequency are within limits. The PCS100 UPS-I is ready to back up the load in case the utility voltage or frequency goes beyond the thresholds
Inverter not ready	Inverter Not Ready

Discharge t/o	The PCS100 UPS-I has returned to the utility supply. The PCS100 UPS-I has been running on energy storage for longer than parameter 520 Maximum Active Time.
Discharge overload	The PCS100 UPS-I has returned to the utility supply. The UPS-I is at current limit for an extended period or the heatsink is hot.
Storage empty	Load is operating from the utility supply. The energy storage is drained (The DC voltage is less than 554VDC).
Discharging	The utility voltage or frequency is out of limits. The PCS100 UPS-I has transferred to energy storage.
Walking in	The PCS100 UPS-I is transferring from energy storage back to the utility.
Test Mode run	Test mode has been activated. See **Parameter 912**

Table 7-4: PCS100 UPS-I Status Messages

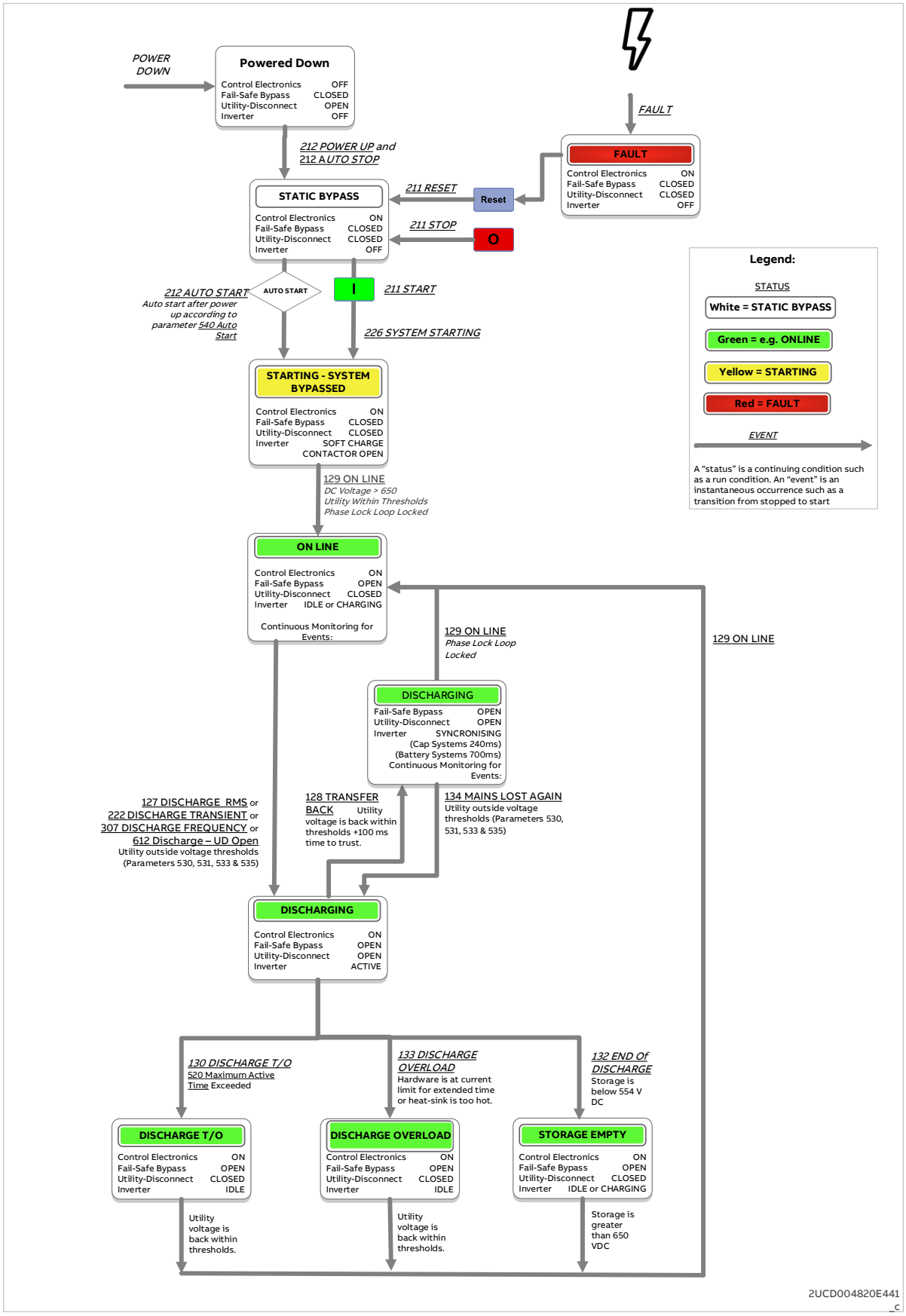


Figure 7-6: PCS100 UPS-I state flow diagram

For Status message descriptions see Table 7-4. For Event descriptions see Table 11-2

7.1.4 Event Log Page

The PCS100 UPS-I incorporates an event log that stores a chronological list of events. This is useful for diagnosing PCS100 UPS-I operation and system power quality events.

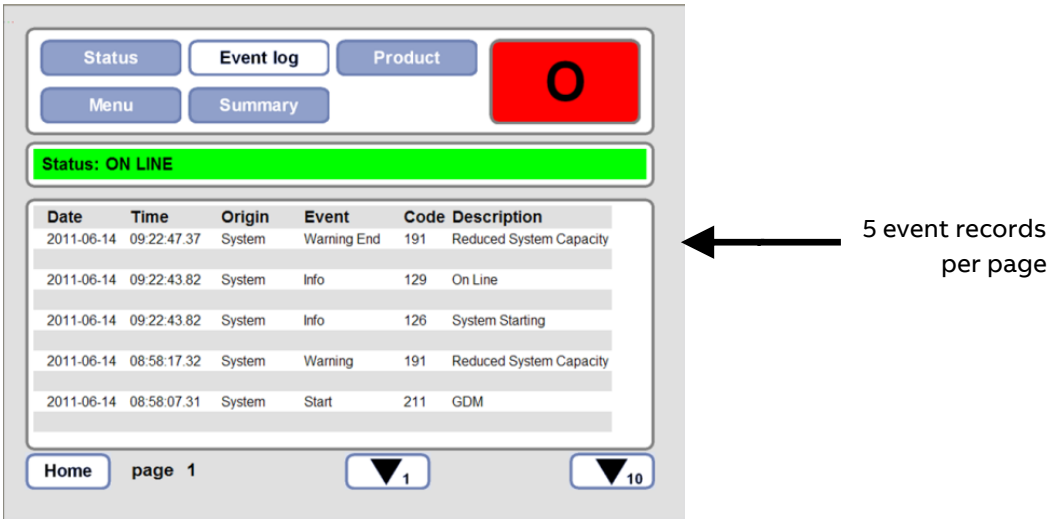


Figure 7-7: GDM Event Log Page

Accessing the event log page uploads the most recent event records with the most recent events at the top. Each page shows five event records referenced by the date and time.

The event log records can be scrolled through using the up 1, down 1, up 10 and down 10 arrow keys at the bottom of the page. The page number is shown at the bottom of the screen. Pressing the home button will return to page 1 and upload the most recent event records in the system.

A maximum of 10,000 events can be recorded. When more than 10,000 events occur the new events replace the oldest events.

The event log cannot be cleared.

7.1.4.1 Interpreting the Event Log

Figure 7-7 shows a typical event log page.
The events recorded are divided into 2 categories:

1. System events, i.e. PCS100 UPS-I faults, warnings etc.
2. Power Quality events, i.e. voltage sags and voltage surges.

System Events
Each System Event is displayed on a single line which displays the following information:

Information Type	Description
Date	The date the event occurred
Time	The time the event occurred (to 10ms resolution).
Origin	Fault, Warning and Auto Bypass events may be originated from the Master or Inverter modules. See Table 7-7
Event	The event types. See Table 7-6 and Table 7-9
Code	The unique numerical code for the event. See Section 11
Description	For a system event this column shows the description of any Fault or Warning. See Section 11 for a full list of event descriptions.

Table 7-5: Event Log Columns

Event Type	Description
Charge End	The inverter modules have completed charging the energy storage.
Charge Start	The inverter modules have started charging the energy storage.
Clock Set	The system clock has been set, manually or by the NTP time synchronization service.
Fault	A fault has occurred. The PCS100 UPS-I cannot be started until the fault is removed.
Fault Reset	At Fault has been reset.
Force	The event has been forced using parameter **630 Generate Event**.
Info	Information – A change of status has occurred
Local Fault	A fault in an inverter module. This will be logged as a warning.
Power Up	The PCS100 UPS-I has powered up.
Reset	A reset command has been received.
Start	A start command has been received.
Stop	A stop command has been received.
Warning End	A Warning condition has ended. Warning End events are only recorded for events where the “System” in the origin. (see Table 7-7).
Warning Start	A Warning condition has started. The PCS100 UPS-I can still function but it may have a reduced capacity.

Table 7-6: System Event Types

Origin	Description
System	Events originating from the Auxiliary Master Module, Utility Disconnect, Float Charger or Fail-Safe Bypass.
Inverter x	The fault or warning originated from the inverter module 1 to 20.

Table 7-7: System Event Origins

Power Quality Events
Each Power Quality Event is displayed on two lines. Each line displays the following information:

	Value	Description
Line 1	Date	The date the event occurred
	Time	The time the event occurred (to 10ms resolution).
	Event	The event type – see Table 7-9
Line 2	Status	The PCS100 UPS-I status at the end of the event. See Table 7-3: PCS100 UPS-I Status Bar Colors
	Duration	The time between event start and event end in milliseconds.
	Input Voltages	Sag minimum supply voltages (V1 –$V3_{Supply}$) Surge maximum supply voltages (V1 –$V3_{Supply}$)
	Output Voltages	Maximum load voltage (V1 – $V3_{Load}$)

Table 7-8: Power Quality Event Information

Event Type	Description
Sag start	The start of a sag has been detected.
Sag end	The end of a sag has been detected
Surge start	The start of a surge has been detected.

Surge end	The end of a surge has been detected.

Table 7-9: Power Quality Event Types

7.1.4.2 Additional Event Information

For events in the event or fault log pages that display an icon, clicking the respective line in the event log displays additional information about the event.
The Modules section displays which of the PCS100 modules in the PCS100 UPS-I are reporting the event.
The Description field contains an extended description of the event.
The Recommended Action field is only visible when logged into the GDM at the 'Tech' level as it is primarily provided to aid trained ABB service agents resolve the fault.
Both the Description and Recommended Action fields are also presented in the Table 11-2: PCS100 UPS-I Event Descriptions.

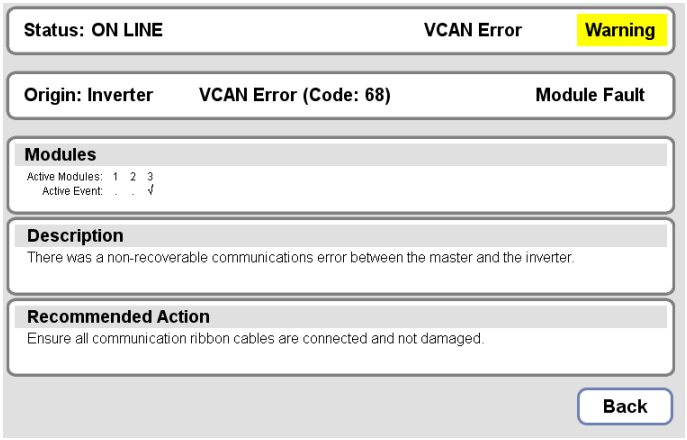


Figure 7-8: Additional Event Information

7.1.5 Product Page

The product page records information about the product and site.

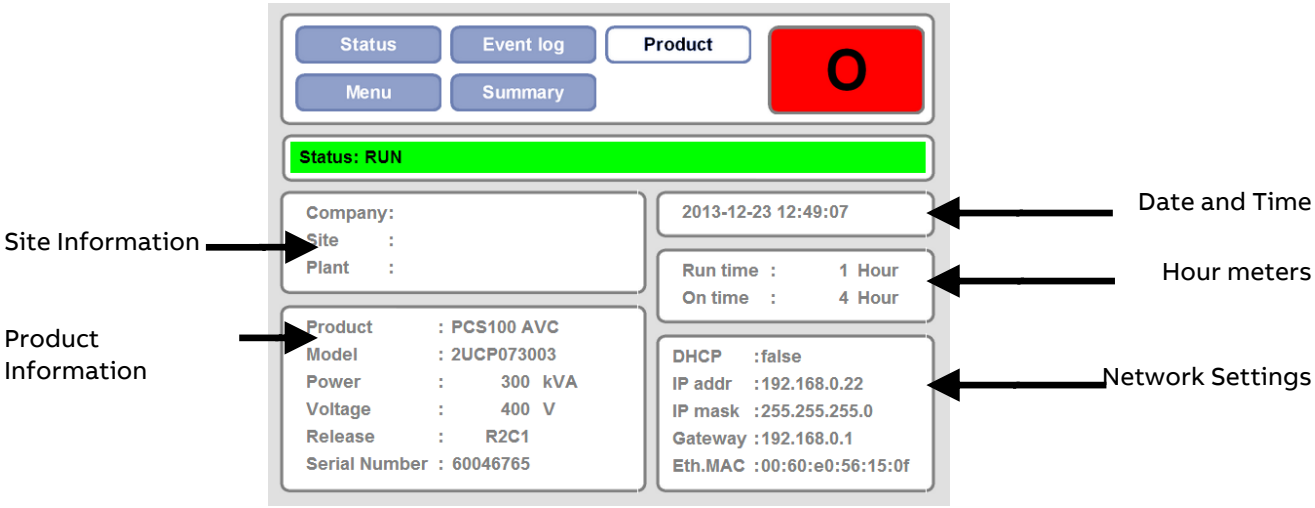


Figure 7-9: GDM Product page

The information displayed in Product Page:

Item	Description
Site Information	Name of Company, Site and Plant Entered during commissioning in Menu 200
Product Information	Product Name and Model Power and Voltage rating SW version and Serial No. Entered during production
Date and Time	Current Date and Time Entered in menu 000
Hour Meters	Total hours running an total hours on (powered up)
Network Settings	Ethernet network parameters Entered in Menu GDM B00 Network Settings

Table 7-10: GDM Product Page information

7.1.6 Menu Page

The menu provides access to the PCS100 UPS-I and GDM parameters for viewing and/or adjustment.
It is organized into menus and sub menus which contain the parameters. Each folder and parameter is indexed by three characters to the left of the name.
The navigation panel shows the current position in the menu.

For a full listing and description of the parameters refer to Section 10.

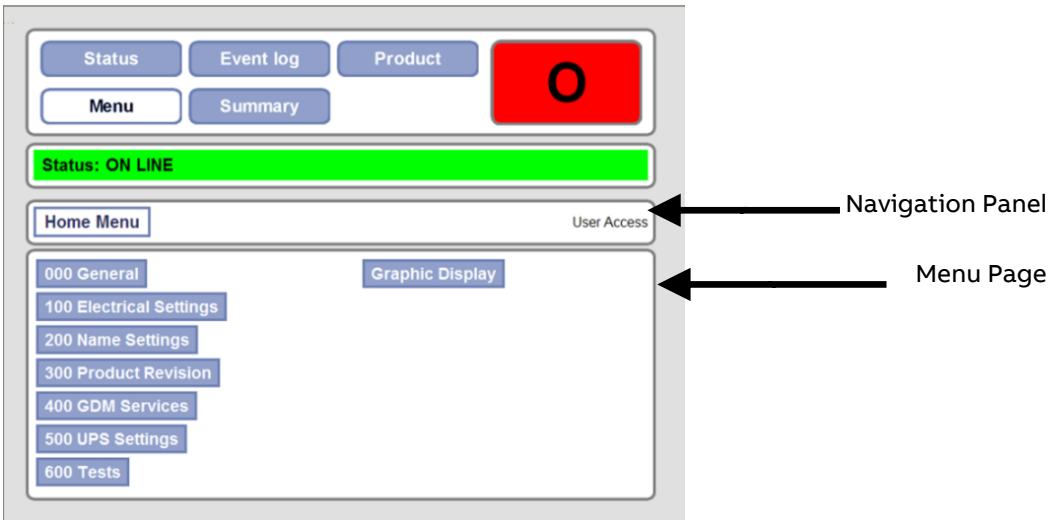


Figure 7-10: GDM Menu Page

7.1.7 Summary Page

The Summary Page shows the running totals of power quality events in various voltage ranges.

The totals are cleared via parameter **052 Reset Power Quality**.

The time the summary was last cleared is shown at the bottom of the page.

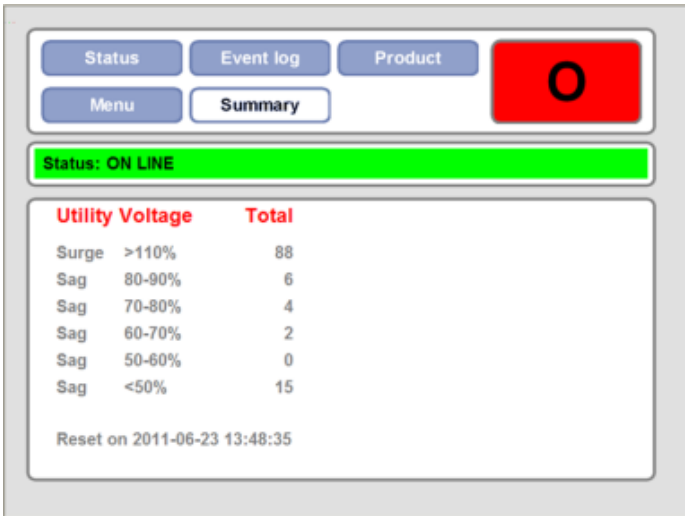


Figure 7-11: GDM Summary Page

7.2 Utility Disconnect Status LEDs

Utility Disconnect Status LEDs show local status information about the Utility Disconnect. This information is generally not reproduced on the GDM.

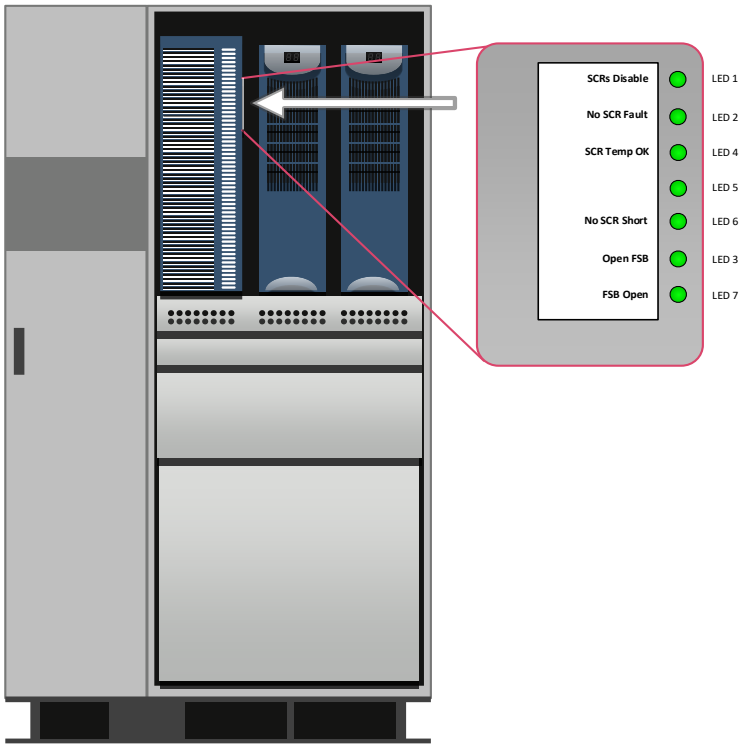


Figure 7-12: 900 A Utility Disconnect Status LEDs

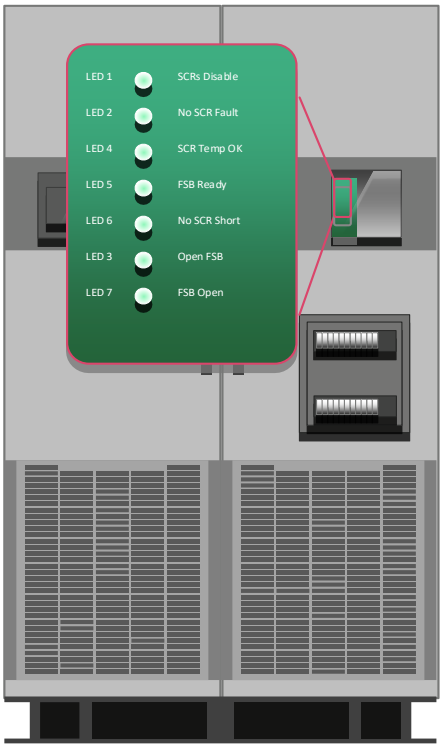


Figure 7-13: 2200 A and 4200 A Utility Disconnect Status LEDs

LED (Top to bottom)	**Name**	**Condition when LED is illuminated**
LED 1	SCRs Disable	The SCRs have received a signal from the master controller to switch off. This only occurs during a discharge.
LED 2	No SCR Fault	The SCRs are firing correctly (feedback from SCR firing PCB). When there is an SCR firing fault this LED will switch off and event code 93 will be recorded in the event log. When the SCRs are intentionally disabled by the master during a discharge the LED will switch off, but no event will be recorded in the event log.
LED 4	SCR Temp OK	The SCR heat sink 90°C sensors indicate the heat sink temperature is less than 90°C. When the sensors indicate over 90°C this LED will switch off and event code 145 will be recorded in the event log.
LED 5	Not Used (900 A UD)	LED 5 is not used for small PCS100 UPS-Is with 900A UD.
	FSB Ready (2200 A/4200 A UD)	The FSB is ready to operate. When the FSB is not ready the LED will switch off and event code 221 will be recorded in the event log.

LED 6	No SCR short	Indicates that no UD SCR is shorted, or stack is not bypassed (e.g., FSB closed). Led 6 is off when there is a very low voltage across an SCR. Note: This LED indicates a shorted SCR by detecting a lower-than-expected voltage across the SCR. This condition also occurs when an FSB or external Bypass is closed, or if load current is very low or zero. Indication is meaningful when in online mode with >10% load current.)
LED 3	Open FSB	Command exists from the master to open the FSB. This will occur when the PCS100 UPS-I is Online and there are no faults.
LED 7	FSB Open	The FSB is open (feedback from the ACB aux contacts)

Table 7-11: Utility Disconnect Status LEDs

7.3 PCS100 Inverter Display Boards

The PCS100 Inverter modules contain their own display boards which contain the RUN and OK LEDS, as well as 2 x 7 segment LED displays.
The 7 segment displays show the individual module identification number (1 – 32), however if there is an error condition they will flash alternately every 500 ms the module identification number and an error code. On start-up they will show L0 and L1 indicating the states in the start-up sequence.

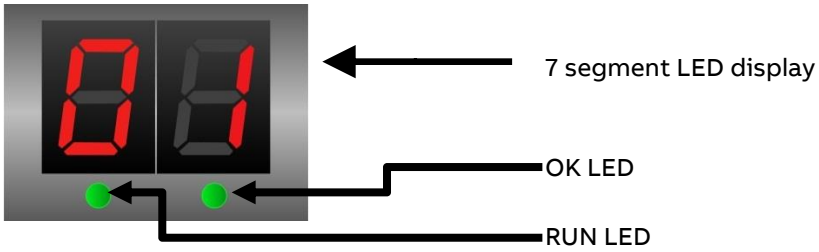


Figure 7-14: Module Status LEDs

7 segment LED display	Product Status or Description
OFF	Not powered
"**L0**" and the module number FLASH (50% duty, 1sec period)	Booting. This is normal just after power up.
"**L1**" and the module number FLASH (50% duty, 1sec period)	Configuring. This is normal during start up after booting (L0) has completed.
"**ou**" and the module number FLASH (50% duty, 1sec period)	The module is running, and it has been configured as an inverter (output). This is displayed for about 2 minutes after configuration (L1) is completed.
"**E0**" and the module number FLASH (50% duty, 1sec period)	A fault has occurred in the module. See error message on GDM
1 to 32. Module number	The module is running. This is displayed after configuration (L1) is completed.
"**E1**" and the module number FLASH (50% duty, 1sec period)	Problem starting the module – invalid parameter/s. No communication with DSP (digital signal processor) in the master module. Possible DSP hardware failure.
"**E2**" and the module number FLASH (50% duty, 1sec period)	Problem starting the module – invalid parameter/s.
"**u0**" and the module number FLASH (50% duty, 1sec period)	Requested operation mode: using internal dip switch setting.
"**u1**" and the module number FLASH (50% duty, 1sec period)	Requested operation mode: rectifier/input module (not applicable to PCS100 UPS-I).
"**u2**" and the module number FLASH (50% duty, 1sec period)	Requested operation mode: inverter/output module.

Table 7-12: 7 segment LED displays

OK LED	**Product Status or Description**
OFF	Not powered
ON	No Fault and microprocessor functioning
FLASH (50% duty, 1sec period)	FAULT, WARNING or module boot up stage.

Table 7-13: OK LED displays

RUN LED	**Product Status or Description**
OFF	Module stopped
ON	Module active
FLASH	Module boot up stage

Table 7-14: RUN LED displays

8 OPERATING PCS100 UPS-I

8.1 Starting and Stopping PCS100 UPS-I

The primary method of starting and stopping the PCS100 UPS-I is via the Graphical Display Module (GDM) which is mounted in the door of the master inverter enclosure. This is deemed Local Control. Start/Stop control of the PCS100 UPS-I via the digital I/O terminals (Section 13.2) is deemed Remote Control.

8.1.1 GDM Control

The Start (I) / Stop (O) /Reset button in the Navigation & Control Panel allows GDM control of the PCS100 UPS-I. When the PCS100 UPS-I is stopped (Bypass) a green Start (I) button will show, and when running (RUN) a red Stop (O) button will show. Pressing the Start (I)/ Stop (O)/ Reset button followed by YES in the following confirmation screen will cause that action to be taken. Figure 8-1: GDM Status Page shows the status page when the PCS100 UPS-I is running.

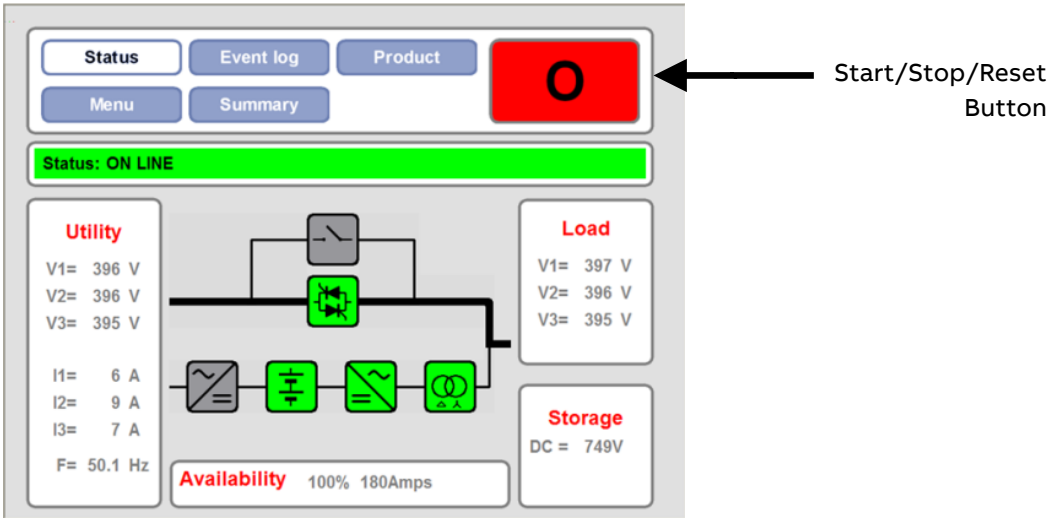


Figure 8-1: GDM Status Page

Note: If parameter **A31 GDM Control Enable** is set to False the Start/Stop/Reset button will not be displayed.

Start the PCS100 UPS-I

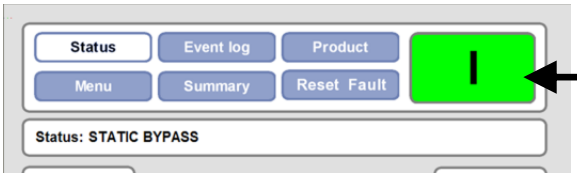


Figure 8-2: Start button

The Start button is visible when the PCS100 UPS-I status is Static Bypass (Off).
Press the Start button and press “Yes” at the confirmation screen. The PCS100 UPS-I will transition to RUN operation in approx. 1sec.

Stop the PCS100 UPS-I

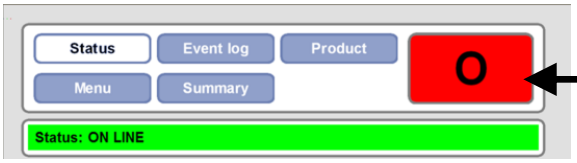


Figure 8-3: Stop button

The Stop button is visible when the PCS100 UPS-I status is Run.
Press the Stop button and press “Yes” at the confirmation screen. The PCS100 UPS-I will transition to Static Bypass (Off) in approx. 1sec.
On systems fitted with an FSB the closing of the FSB can be heard.

Note: When the stop button is pressed the Utility Disconnect will remain closed. Therefore the load will not be dropped, however the UPS-I will not back up the load in the event of a utility failure.

Reset the PCS100 UPS-I

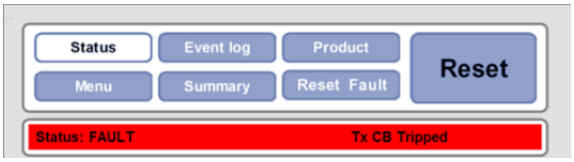


Figure 8-4: Reset button

The Reset button is visible when the PCS100 UPS-I status is Fault.

Press the Reset button and “Yes” at the confirmation screen to reset a fault.

Start Inhibit

Figure 8-5: Start Inhibit button

The Inhibit button is visible when the Inhibit switch or the remote stop input is closed.
The PCS100 UPS-I cannot be started until these inputs are closed
The Inhibit switch is inside the enclosure door.
The remote stop input is on the front of the auxiliary master module, see Section 13.2.

On-Line Reset

Figure 8-6: Reset Fault button

The Reset Fault button provides a method for on-line resetting of a range of recoverable module faults.
It is only displayed when an inverter module fault is present but the UPS-I remains On Line due to the redundancy function.

8.1.2 Remote Control

Start, Stop & Reset control via the digital inputs on the front of the Master Auxiliary module (see Figure 13-1: Remote Control and Monitoring Terminals) is deemed Remote Control.

Control	Method
Start	When the Start input closes (terminals 12 & 13) the PCS100 UPS-I will start (Online) in approx. 1 sec.
Stop	When the Stop/Reset input opens (terminals 14 & 16) the PCS100 UPS-I will transition to stop (Static bypass) in approx. 1sec. The stop always has priority over the start.
Reset	When the Stop/Reset input transitions from open to close the PCS100 UPS-I will reset a fault condition if the cause of the fault has been cleared.

Table 8-1: Remote Start/Stop control

A Stop input has priority over any start command. When a Remote Stop is active “INHIBITED” will show on user interface as shown above.

8.1.3 Start/Stop Configuration

The PCS100 UPS-I is configured for GDM control by default in the factory.
The PCS100 UPS-I can also retain its previous run status following a power cycle. The default setting is that the run status will be retained, therefore the PCS100 UPS-I will return to the previous state after the next power up.

Parameter **541 Start Command** modifies how the Local and Remote controls work together.

Parameter **540 Auto Start** determines the start status through a power down/ power up cycle.

9 ADVANCED FUNCTIONAL DESCRIPTIONS

9.1 Voltage Event Detection

The PCS100 UPS-I is classified as a single conversion UPS of the type VFD according to IEC62040-3. That is, the voltage and frequency are protected but are dependent on the supply in normal operation.
In the event of an outage, sag, surge, overvoltage, undervoltage, excessive phase and frequency deviation on the utility supply the PCS100 UPS-I will transfer the load to the backup energy storage via an inverter (Discharge mode).

The PCS100 UPS-I incorporates an advanced Voltage Event Detector control block with function to identify when to transfer the load from the utility supply voltage (Online mode) and on to the inverter system (Discharge mode). This must be done quickly to limit the exposure of the load to out of tolerance utility voltage but should not be so sensitive to normal utility supply disturbances such as switching transients, background voltage harmonics or events caused by the load causing unnecessary transfers. Excessive transfers to the inverter and energy storage supply should be avoided as these can shorten the life of the energy storage element, create additional disturbance, and leave the energy storage in a discharged state where it is not prepared to manage a true event.
The PCS100 UPS-I Voltage Event Detection is a combination of three complementary voltage event detection methods targeting different voltage event characteristics:

- RMS detector
- Transient detector
- Frequency detector

The default voltage event detection response is shown in the following curves.
Four curves are shown in each of the figures. The 100% Un represents the curve when the historical voltage was at the nominal value for the supply. The 90% Un and 110% Un represent the condition where the historical voltage was 10% below and 10% above the nominal voltage. The IEC62040-3 limit is a reference baseline curve and represents the curve required to meet the IEC62040-3 UPS standards for Classification 2 with 0.5 ms allowance for transfer to the inverter operation.

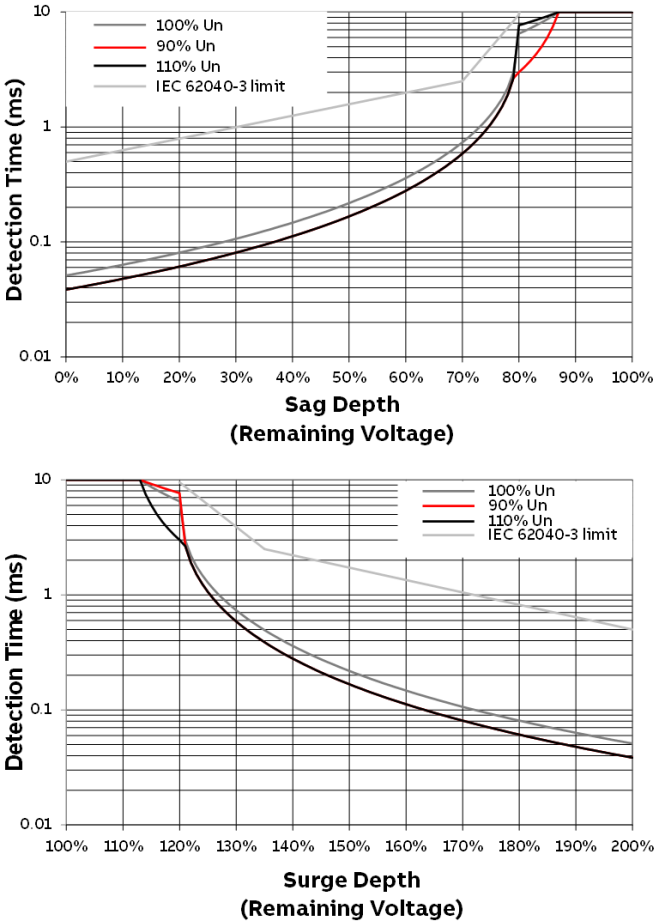


Figure 9-1: Default voltage event detection response curves

9.1.1 RMS detection

RMS detection is a slow response detection based on the deviation of the utility supply RMS voltage from the supply voltage set point. Because RMS measurement has a minimum measurement time of 1/2 cycle the maximum response rate of this detection can take up to 1/2 cycle.
This method is sensitive to half-cycle voltage changes and will reject harmonic voltage deviations apart from their minor impact on the total RMS value.
The RMS detector is responsible for detecting the smaller sag, surge, overvoltage and undervoltage events but is insensitive to phase changes.

The thresholds for this detection are set by parameters **530 RMS Sag Threshold** and **531 RMS Surge Threshold** with the supply voltage set point parameter **121 Utility Voltage**.

When the RMS detection is triggered the PCS100 UPS-I will display “127 Discharge RMS” in the event log.

9.1.2 Transient detection

Transient detection is a fast response detection based on the deviation of the utility instantaneous voltage from the instantaneous value of the utility supply voltage set point. It monitors the instantaneous three phase voltage vector and compares it with an ideal voltage vector which is phase locked to the historical utility supply voltage. This detector is sensitive to large momentary voltage disturbances like deep sags and surges, outages including phase jumps and frequency deviation and is the primary mechanism used to rapidly initiate a transfer when a major voltage event occurs.
To prevent false transfers occurring due to harmonic distortion or switching transients on the supply the transient detector is carefully optimized.

Additionally to Transient detector optimization, the PCS100 UPS-I incorporates a source impedance voltage drop compensation which ameliorates harmonic voltage disturbance at the point of coupling which is commonly caused by the connected load causing voltage drops across the supply impedance.

There is always a requirement for some delay in detecting a voltage event and filtering due to reject noise typical of most power systems. The default parameters have been chosen carefully to balance the need for rapid response to real events against the desire to reject nuisance disturbances.

The response of this detection is set by parameter **532 Transient Threshold** with the supply voltage set point parameter **121 Utility Voltage**.

When the Transient detection has been triggered the PCS100 UPS-I will display "222 Discharge Transient" in the event log.

9.1.3 Frequency detection

Frequency detection is based on the deviation of the Supply frequency from the supply frequency set point.

The threshold for this detection is set by parameter **533 Frequency Threshold** with the supply voltage set frequency parameter **122 Utility Frequency**.

When the frequency detection is triggered the PCS100 UPS-I will display “Discharge Frequency” in the event log.

Frequency detection typically is only used on supplies where the frequency can vary widely. The default threshold setting is such that the detection will not be triggered when connected to a grid.

9.2 Transfer Description

As a single conversion type UPS the PCS100 UPS-I will transfer the load from the utility supply to the backup energy storage if it detects a deviation of the supply voltage from the nominal value by more than that set by the PCS100 UPS-I set points.

The PCS100 UPS-I is classified as VFD SX 211 for rated powers below 450 kVA and VFD SS 211 for rated powers above 450 kVA according to IEC 62040-3.
According to this classification, the PCS100 UPS-I complies with Classification 2 (**2**11) performance for change of operating mode from utility supply mode to energy storage mode.

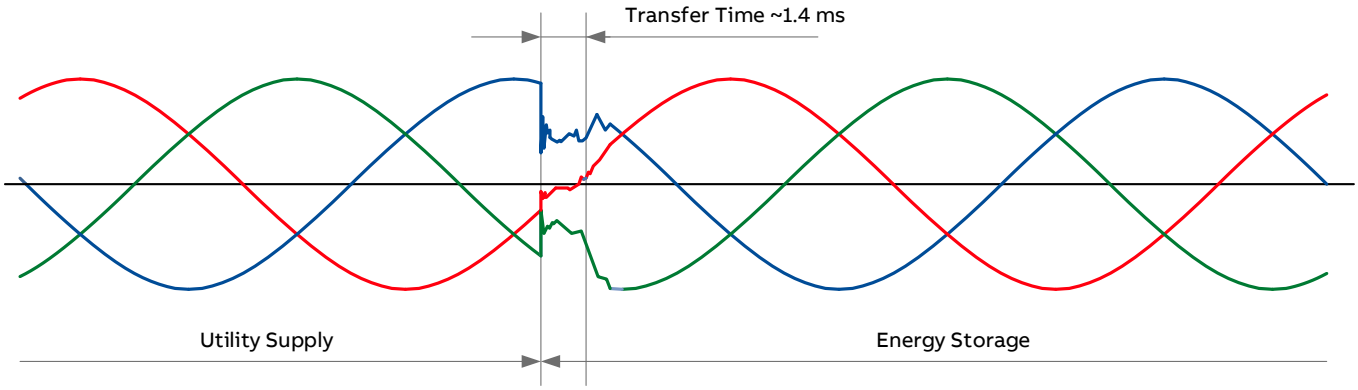
The transfer from utility supply mode to energy storage mode is done by closing the Utility Disconnect which consists of a naturally commutated SCR based electronic switch.
A SCR (thyristor) is a naturally commutated device that turns off at the next zero crossing, which could be as long as 10 milliseconds later, and this presents problem when the need arises to immediately transfer the load at any point in the cycle, i.e. to achieve transfer performance according to IEC 62040-3 Classification 2.

When turning off the Utility Disconnect, the PCS100 UPS-I utilizes revolutionary PCS100 Inverter commutation capability techniques to force the current in the Utility Disconnect and turn SCRs off with typical transfer time of 1.8 milliseconds, resulting the minimum load voltage disturbance.
Without PCS100 Inverter commutation the Utility Disconnect SCRs would continue to conduct until the current naturally decays in next zero crossing which may take up to ½ of a cycle.

When a transfer is performed the PCS100 UPS-I status line will change from “On Line” to Discharging”

When the supply returns within these limits a “transfer back” sequence is initiated. First the PCS100 UPS-I will wait a short time to trust the supply is stable. Then it will resynchronize with the mains supply. Finally it will switch on the Utility Disconnect and transfer back to the utility supply. If during this time the Energy Storage is depleted it will transfer back regardless.

The following image shows a typical waveform of the PCS100 UPS-I output voltage during transfer from utility supply to energy storage mode.



9.3 Redundancy

The PCS100 UPS-I inverter consists of multiple 150 kVA PCS100 inverter modules connected in parallel. If one inverter module fails the PCS100 UPS-I will reconfigure itself to operate with the remaining modules. A maximum of 50% of the modules can fail before the PCS100 UPS-I will trip out.

- Faults that result in a module going offline but remaining connected to the master controller (via the serial communications CAN bus) are able to be reset. Examples of such faults are Event 55 Sin Filter Hot and other temperature faults, current trips, voltage trips, power supply trips etc.

- Faults that result in the module being disconnected from the VCAN bus network are not able to be reset and will require a Reboot using Parameter **051 System Reboot**. A module can only be reinstated to the VCAN bus network by rebooting the PCS100 UPS-I. Such faults occur when the module 27 Vdc power is lost or there is a VCAN bus failure.

- Faults that result in a module being disconnected from the VCAN bus network are permanently excluded from the system even if the power is cycled. A reboot must be performed to reinstate such modules.

9.4 Energy Storage Description

Energy Storage charging functionality is the part of the system that replenishes the energy consumed from the energy storage after the system operates, as well as the initial charge (from 0 V) of Ultracapacitor strings.

Two methods of charging are provided with PCS100 UPS-I system:
- PCS100 Inverter fast charging
- Float Charger

9.4.1 PCS100 Inverter fast charging

Due to bi-directional power flow design of the PCS100 Inverters high power PCS100 Inverter fast charging is implemented in the PCS100 UPS-I system. The PCS100 Inverters send power from the utility supply to replenish the Energy Storage following any significant discharge operation.
Once the PCS100 UPS-I is On Line the PCS100 Inverter fast charging will charge energy storage from 554 V to the maximum storage voltage.

Charging time of the PCS100 Inverter fast charging is dependent on the settings of the charging current through the parameter **711 Charging Current**. Charging current level during PCS100 Inverter fast charging period can be set between 0% and 40% of inverter rated current, with standard setting of 10% for battery models and 20% for Ultracapacitor models.

Note:
During complete electrical system design precaution should be taken for the PCS100 UPS-I system supply transformer capacity, especially for battery models because of the battery charging period after PCS100 UPS-I discharging mode.
As fast charging of batteries through the PCS100 UPS-I inverters can be up to 30 minutes. The additional load on the supply transformer should be taken in consideration.

Typical recharging times are shown in Table 9-1.

Energy Storage	System Type	Note	Voltage range	Recharge time
Ultracapacitor	0.8 PF, 20% charging current	Discharged with 10% - 100% of rated load power	630 - 750 V	16 – 18 seconds
		Discharged with <10% of rated load power	560 - 750 V	30 – 32 seconds
	1.0 PF, 20% charging current	Discharged with 10% - 100% of rated load power	630 - 750 V	20 - 23 seconds
		Discharged with <10% of rated load power	560 - 750 V	37 - 40 seconds
Battery	0.8 PF, 10% charging current	Discharged with 0% - 100% of rated load power	554 - 780 V	up to 30 minutes

Table 9-1: Typical PCS100 UPS-I Energy Storage recharging times.

9.4.2 Float Charger

Once the energy storage is largely recharged, the PCS100 Inverter fast charging is turned off and the Float Charger is left to provide fine control and efficient floating.
The Float Charger is an independent isolated switch mode charger rated 1.5 kW + 1.5 kW, 4 A, for +/- 375 Vdc (Ultracapacitors) and +/- 390 Vdc (batteries) supplies.

Additional function of the Float Charger is initial charging of Ultracapacitor Energy Storage, from 0 V to 650 V, after the PCS100 UPS-I is powered up and before the PCS100 UPS-I can Run (On Line). Once the PCS100 UPS-I is On Line the PCS100 Inverter fast charging will charge from 650 V to the maximum storage voltage.

Note:
Initial charging time of the Ultracapacitor Energy Storage, from 0 V to 650 V, is up to 120 minutes.

9.5 Generator Walk-In

The PCS100 UPS-I with Battery Energy Storage with 30 seconds autonomy is typically used to bridge start-up time for stand-by generator backup systems where critical applications may be subject to longer supply outages.

If a stand-by generator is included in the installation it is connected to the Automatic Transfer Switch (ATS). Generally, stand-by generator is started automatically in the event of a utility supply failure.
The Automatic Transfer Switch transfers to the generator when it detects that the generator voltage is stable. When the utility supply is restored, the ATS disconnects stand-by generator and reconnects utility supply.

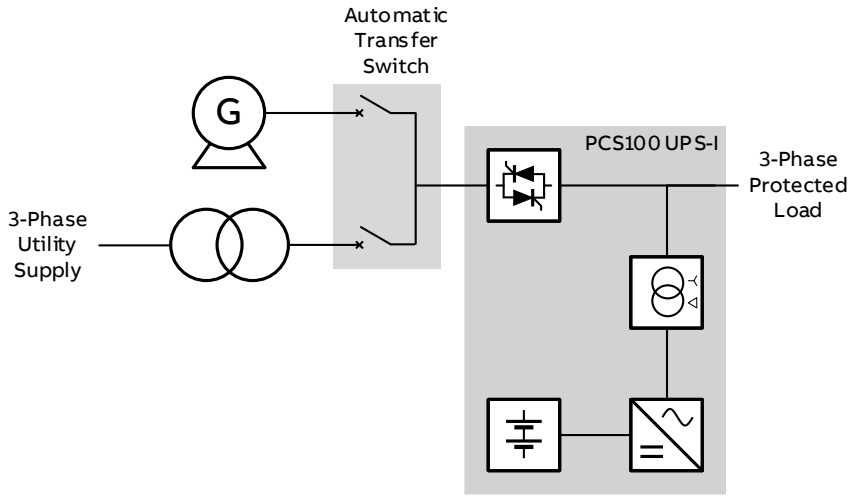


Figure 9-2: PCS100 UPS-I combined with stand-by generator

The PCS100 UPS-I needs to support the need to transfer load back to a generator supply from the energy storage mode of operation. However, a step transfer of load to generator (or weak utility supply networks) will result in the voltage and/or frequency disturbance on the generator terminals exceeding the transfer threshold. The result would be a transfer back to the stored mode.

The Generator Walk-in function of the PCS100 UPS-I supports controlled transfer of the load to stand-by generators.
The transfer to the generator will be made when the generator voltage has been stable and within the acceptable bounds as defined by the voltage event criteria. Then the inverter will synchronize to the generator supply and continue to support the load. A linear ramp is imposed on the set-points, ramping the support to generator to zero over a defined time. Once the ramp down is complete the walk-in process is complete and the PCS100 UPS-I reverts to charging mode.

The transfer sequences utility supply – energy storage – generator and generator – energy storage - utility supply are fully automatic and the load is not affected during automatic switch transfers.

The generator walk-in time can be set through parameter **521 Walk in Time** in range from 0 seconds to maximum 8 seconds.

The following image shows the timing diagram of the PCS100 UPS-I Generator Walk-in functionality in the common stand-by generator back-up system with an automatic transfer switch. It can be seen that the load supply is not affected in any case.

Note that the duration of individual events is not in scale.

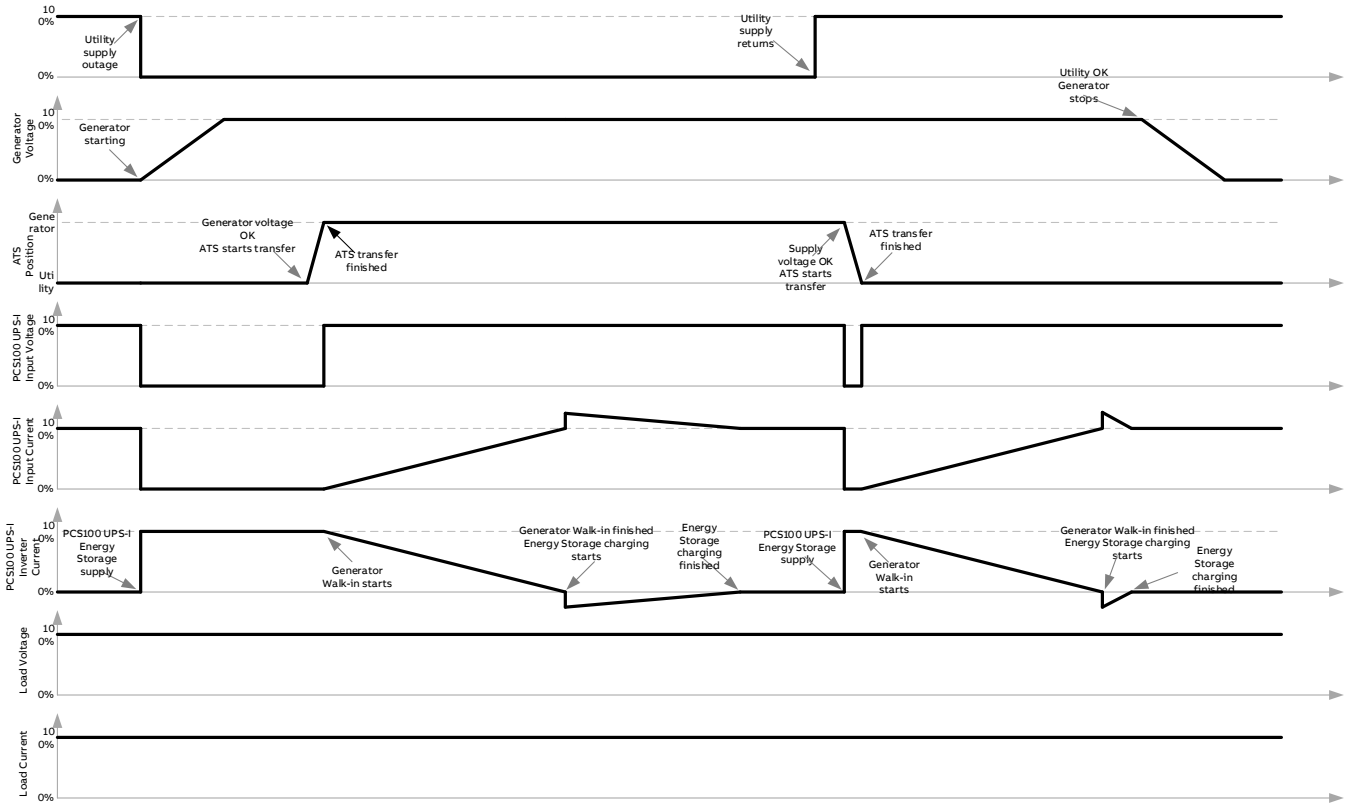


Figure 9-3: PCS100 UPS-I Generator Walk-in functionality timing diagram

9.6 Fan Control Service

To extend the life of the PCS100 UPS-I Inverter module cooling fans they do not run continuously. The temperature of the inverter electronics is monitored and triggers a fan operation to circulate cooling air. All module temperatures are monitored and the worst case is used to trigger the fans.

The temperature is sensed in the control electronics area of the PSC100 Inverter modules and temperature greater than a threshold value will trigger the PCS100 Inverter fan to run for 6 minutes on, then 14 minutes off by default. The fan off time is required to ensure that the sensor is measuring the module temperature, not the ambient temperature. Furthermore, the ratio between the fan on time and fan off time determines the duty cycle therefore the fan off time needs to be at least twice as long as the fan on time to ensure the fans last their stated 15 years life time.

While the fan on and off times can be adjusted in menu **D40 Fan Control Service**, It is recommended that these be left at the default values.

ABB recommends setting the parameters as follows.

D402: Fan Control Enabled	true
D403: Fan On Time	6 min
D404: Off Time	14 min
D405: Temperature Threshold	34 °C

The above parameters can be entered using ‘tech’ access.

The ‘D404 Off Time’ is recommended to be at least twice as long as the ‘D403 Fan On Time’ to ensure the module fans comply with their 15 year lifetime. The setting above will turn on the module fans for 6 minutes followed by 14

minutes of off time. At the end of this period, the module temperature will be checked and the fan will be turned on if any of the module fans report temperature greater than ‘D405 Temperature Threshold.’

9.7 Neutral Current

The PCS100 UPS-I transformer has a partially rated neutral which should not exceed 5% of the UPS-I rated current. Neutral current may be caused by load imbalance or utility voltage imbalance.

The PCS100 UPS-I will generate Event Code 12 when the neutral current exceeds 5% of the rated current. The Coupling Transformer circuit breaker will trip if the neutral current exceeds 10% of the rated current.

10 PARAMETERS

10.1 Parameter Setting (Menu Page)

Parameter setting is performed by the GDM Menu pages, as shown Figure 10-1.

Menu Page is organized into menus and sub menus which contain the parameters. Each parameter is indexed by three characters to the left of the name.

The current position in the menu is displayed in the Navigation Panel.

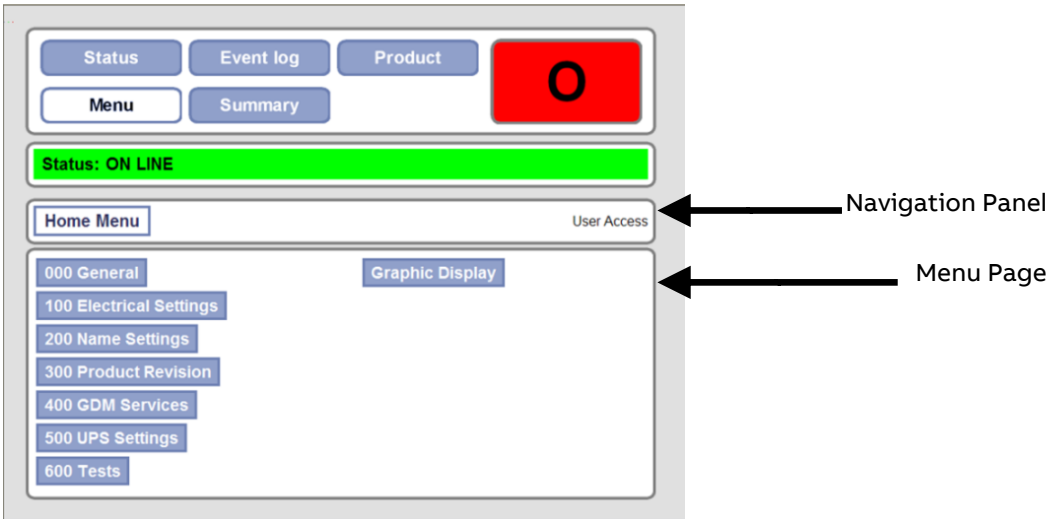


Figure 10-1: GDM Menu Page

10.1.1 Menu Navigation

Pressing on any menu folder in the navigation panel or menu page will navigate to that position in the menu, and update the navigation panel to show the new position.
Parameters that are read only are shown in grey. Parameters that are adjustable are shown in blue. Pressing on an adjustable parameter will present the ‘edit menu’ screen. For numeric values this will show a keypad and for non-numeric values this will show the options for that item. Press ‘Apply’ to accept the adjustment, or ‘Cancel’ to revert to the previously stored value.
When exiting the Menu the GDM remembers the current menu page and returns there when the user next accesses the menu.

10.1.2 Parameter Access Control

There are 2 menu levels on the PCS100 UPS-I.
Menus are security protected by a password to stop unauthorized access.

10.1.2.1 Operator menu

Parameters in the Operator menu are suitable for adjustment by the operator. It is made accessible by entering operator password to parameter **011 Password**.
When the Operator menu is accessible “Operator Access” is displayed in the right side of the navigation panel.

Operator password is: 159

10.1.2.2 Tech menu

Parameters in the Tech menu are suitable for qualified technicians. It is made accessible by entering Tech password to parameter **011 Password**.
When the Tech menu is accessible “Tech Access” is displayed in the right side of the navigation panel.

When neither menu is accessible “Not Logged In” is displayed in the navigation panel.

Note: After a menu has been active for 30 minutes it will automatically log out of that menu.

10.2 Parameter Index

Menu number & name		Parameter number & name				Page
000	**General**	011	Login	052	Reset Power Quality	80
		041	Date and Time	053	Set Parameter	
		051	System Reboot	061	Show Faults	
100	**Electrical Settings**	112	System Current	131	Sag Recording Thres	82
		113	Module Voltage	132	Surge Recording Thres	
		121	Utility Voltage	141	V Droop Comp R	
		122	Utility Frequency	142	V Droop Comp X	
200	**Name Settings**	211	Company	213	Site	84
		212	Plant			
300	**Product Revision**	311	System Product	333	SCM Revision	85
		312	System Revision	341	CGI Revision	
		330	SCM Boot Product	352	Modbus Revision	
		331	SCM Boot Revision	353	NTP Revision	
		332	SCM Product			
400	**GDM Services**	411	Webserver Status	441	NTP Status	86
		421	Vcanserver Status	442	NTP Server	
		431	Modbus Status	443	NTP Time Zone	
500	**UPS Settings**	520	Max Autonomy Period	534	Transient Value	87
		521	Walk in Time	535	Transient Threshold	
		530	RMS Sag Threshold	536	Transient Filter	
		531	RMS Surge Threshold	540	Auto Start	
		533	Frequency Limit	541	Start Command	
600	**Tests**	611	Test Fan	622	Discharge Min DC	90
		612	Discharge - UD Open	625	Force FSB Closed	
		620	Discharge - UD Closed	630	Generate Event	
		621	Discharge Level			
700	**Charger Settings**	710	Charging Mode	715	Force Float Charger On	92
		711	Charging Current			
800	**Status-Currents**	810	Utility L1	814	Coupling Transformer L2	93
		811	Utility L2	815	Coupling Transformer L3	
		812	Utility L3	816	Coupling Transformer N	
		813	Coupling Transformer L1			
900	**Commissioning**	905	GDM Remote Menus	919	Disconnect	94
		915	Relay Test Mode	920	CESE	
	Graphic Display					
GDM A00	**Display**	A31	GDM Control Enable	A63	SSH Port Enable	95
		A62	Screen Saver Time	A64	Firmware Upload Enable	
GDM B00	**Network Settings**	B11	Dynamic IP DHCP	B14	Static IP gateway	96

		B12	Static IP address	B15	Apply settings	
		B13	Static IP mask			
GDM C00	**Network Status**	C11	Actual DHCP active	C14	Actual IP gateway	97
		C12	Actual IP address	C15	MAC address	
		C13	Actual IP mask	C16	Ethernet Status	
GDM D00	**Product Revision**	D11	GDMIB boot product	D21	GDM revision	97
		D12	GDMIB boot revision	D31	Vcanserver name	
		D13	GDMIB product	D32	Vcanserver revision	
		D14	GDMIB revision	D40	Fan Control Service	

Table 10-1: GDM Menu Index Table

10.3 Parameter Listing

Note:
The parameter adjustment ranges defined in the following section are not necessarily achievable due to system constraints.
Note:
Some parameter visibility depends on the login level of the user.

NOTICE – Trained Operators
All operations on the PCS100 UPS-I must only be carried out by a trained Operator familiar with the contents of this manual. Hazardous conditions could arise from incorrect adjustment.

10.3.1 Menu 000 General

000 General	
The menu contains general system parameters	
Name:	**011 Login**
Function:	To enable or disable access to the Operator menu or the Tech menu
Access:	Continuous
Note:	Enter “159” to access the Operator menu
Parameter	**041 Date and Time**
Function:	To enter the date and time
Format:	YYYY-MM-DD HH:MM:SS
Access:	Operator
Parameter:	**051 System Reboot**
Function:	Restarts all functions within two minutes
Access:	Tech
Range:	True / False
Setting Up:	Select “True” to reboot the PCS100 UPS-I. The parameter will automatically set back to “False” once the PCS100 UPS-I has rebooted. Event 209 will be displayed in the event log.
Parameter:	**052 Reset Power Quality**
Function:	Clears the power quality events recorded in the Summary Page. See Section 7.1.7.

Access:	Operator
Range:	True / False
Setting Up:	Select “True” to clear the PQ events. The parameter will automatically return to “False” once the events have been cleared.
Note:	This parameter does not clear the events recorded in the Event Log.
Parameter:	**053 Set Parameter**
Function:	Provides the ability make a custom adjustment to an internal parameter
Access:	Continuous
Setting Up:	Enter the factory supplied code to change the required internal parameter. When a correct code is entered the message "Parameter Write Result = OK" will be displayed. If an incorrect code is entered the message "Sorry, value entered is not correct" is displayed. This parameter can also be accessed via the Remote Web Pages – see section 12.2.
Note:	The code must be entered exactly. Take care when emailing such codes. Different characters look the same in some fonts. E.g. the lower case letter L looks the same as the numeral one in Times New Roman Font. The Arial Font is OK.
Parameter:	**061 Show Faults**
Function:	Shows all the faults and warnings presently active
Access:	Tech
Note:	Sometimes there can be more than 1 fault or warning active at one time. The most critical fault is displayed on the Status line. This screen shows all the faults and warnings presently active.

Table 10-2: Menu 000 General parameters

10.3.2 Menu 000 Electrical Settings

100 Electrical Settings	
This menu contains electrical settings for the UPS-I	
Parameter:	**112 System Current**
Function:	Set total rated current of system – Line RMS
Access:	Factory Only
Range:	150 A to 5000 A
Units:	Amperes RMS
Factory Setting:	PCS100 UPS-I rated current. (Displayed on the PCS100 UPS-I rating label)
Parameter:	**113 Module Voltage**
Function:	Selects the Inverter module operating voltage
Access:	Factory Only
Setting Up:	With the PCS100 UPS-I this parameter is fixed to 480 V
Parameter:	**121 Utility Voltage**
Function:	Adjusts the PCS100 UPS-I working voltage
Access:	Tech
Range:	Nameplate voltage rating of the PCS100 UPS-I +/- 10%
Units:	Volts RMS
Factory Setting:	Nameplate voltage rating of PCS100 UPS-I
Setting up:	Set to the supply voltage.
Note	This setting also adjusts the output voltage when the PCS100 UPS-I is operating from the backup energy storage.
Parameter:	**122 Utility Frequency**
Function:	Set to frequency of Supply
Access:	Tech
Range:	40 Hz to 60 Hz
Units;	Hz
Factory Setting:	Nameplate frequency rating of PCS100 UPS-I
Setting up:	Set to the supply frequency.
Parameter:	**131 Sag Recording Thres**
Function:	Power quality meter sag recording threshold.
Access:	Operator
Range:	0% to **531 RMS Surge Threshold**
Units:	% of parameter **121 Utility Voltage**
Factory Setting:	90%
Setting up:	This parameter adjusts the recording threshold for sag events recorded in the event log and on the summary page. It does not alter the operation of the PCS100 UPS-I. Should be set the same as or less than parameter **530 RMS Sag Threshold**. If set greater than **530 RMS Sag Threshold** the PQ meter may record part of the pre event sag voltage and give an erroneous reading.

Parameter:	**132 Surge Recording Thres**
Function:	Power quality meter surge recording threshold
Access:	Operator
Range:	**530 RMS Sag Threshold** to 200%
Units:	% of parameter **121 Utility Voltage**
Factory Setting:	110%
Setting up:	This parameter adjusts the recording threshold for surge events recorded in the event log and on the summary page. It does not alter the operation of the PCS100 UPS-I. Set the same as or greater than parameter **531 RMS Surge Threshold**. If set less than **531 RMS Surge Threshold** the PQ meter may record part of the pre event surge voltage and give an erroneous reading.
Parameter:	**141 V Droop Comp R**
Function:	Compensation for voltage drop across the coupling transformer resistance
Access:	Tech
Range:	0.0 to 10.0
Units:	%, base = **121 Utility Voltage**
Factory Setting:	7
Note:	At full load the PCS100 UPS-I inverter output voltage will be increased by this amount to compensate for the voltage drop across the coupling transformer resistance. The compensation voltage will reduce linearly to zero at zero load.
Setting up:	Leave at factory setting.
Parameter:	**142 V Droop Comp X**
Function:	Compensation for voltage drop across the coupling transformer inductance.
Access:	Tech
Range:	0.0 to 10.0
Units:	%, base = **121 Utility Voltage**
Factory Setting:	4
Setting up:	Leave at factory setting.

Table 10-3: Menu 100 Electrical Settings parameters

10.3.3 Menu 200 Name Settings

200 Name Settings	
	This menu contains the settings that are displayed on the Product Page. See section Error! Reference source not found.
Parameter:	**211 Company**
Function:	Company name entry which is displayed on the Product Page (see section **Error! Reference source not found.**) and the downloaded event log.
Access:	Operator
Setting up:	Enter the company name.
Parameter:	**212 Plant**
Function:	Plant name entry which is displayed on the Product Page (see section **Error! Reference source not found.**) and the downloaded event log.
Access:	Operator
Parameter:	**213 Site**
Function:	Site name entry which is displayed on the Product Page (see section **Error! Reference source not found.**) and the downloaded event log.
Access:	Operator

Table 10-4: Menu 200 Name Settings parameters

10.3.4 Menu 300 Product Revision

300 Product Revision	
This menu displays the various PCS100 UPS-I software numbers and revisions.	
Parameter:	**311 System Product**
Function:	Displays the product main software number
Range:	For PCS100 UPS-Is this is “7301”
Parameter:	312 System Revision
Function:	Displays the main system software revision
Range:	Products relating to this manual should be R2F revision or later.
Parameter:	**330 SCM Boot Product**
Function:	Displays the SCM (system configuration Module) boot software name
Range:	The PCS100 UPS-I SCM Boot SW is “7605-010”
Parameter:	**311 SCM Boot Revision**
Function:	Displays the SCM (System Configuration Module) boot software revision
Parameter:	**332 SCM Product**
Function:	Displays the SCM (System Configuration Module) software number
Range:	For PCS100 UPS-I SCM this is “7600-010”
Parameter:	**333 SCM Revision**
Function:	Displays the SCM (System Configuration Module) software revision
Parameter:	**341 CGI Revision**
Function:	Displays the CGI software revision
Parameter:	**352 Modbus Revision**
Function:	Displays the Modbus software revision
Parameter:	**353 NTP Revision**
Function:	Displays the NTP (Network Time Protocol) client software revision

Table 10-5: Menu 300 Product Revision parameters

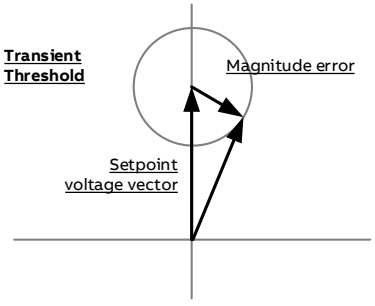
10.3.5 Menu 400 GDM Services

400 GDM Services	
This menu contains the status of various GDM services.	
Parameter:	**411 Webserver Status**
Function:	Displays the status of the webserver.
Range:	Should display “Running” This parameter is not displayed if the webserver service is not available.
Parameter:	**421 Vcanserver Status**
Function:	Displays the status of the Vcanserver.
Range:	Should display “Running”
Note:	Vcanserver is the software module interfacing the CAN bus used by the PCS100 UPS-I master controller to the webserver in the GDM.
Parameter:	**431 Modbus Status**
Function:	Displays the status of the Modbus TCP Service
Range:	Should display “Running”
Note:	After a software upgrade the PCS100 UPS-I needs to be rebooted twice to initialize the Modbus
Parameter:	**441 NTP Status**
Function:	Displays the status of the NTP (Network Time Protocol) client service.
Range:	“Running clock updated” if the NTP server connection is successful. “Invalid Server Name” if no NTP server IP address has been set. “Server connection failed” if no response from the NTP server was received.
Note:	Wait at least 30 seconds after setting the NTP server IP address Parameter **442 NTP Server** before refreshing menu 400 GDM Services. The NTP Status field will be updated when entering the menu.
Parameter:	**442 NTP Server**
Function:	IP address of an NTP (Network Time Protocol) server.
Range:	Any valid IPv4 formatted IP address.
Setting up:	Enter the IP address of the NTP server. Wait for at least 30 seconds before refreshing the ‘400 GDM Services’ menu to check **441 NTP Status**.
Parameter:	**443 NTP Time Zone**
Function:	Specifies the local time zone offset from UTC.
Range:	+/- 13
Units	hours

Table 10-6: Menu 400 GDM Services parameters

10.3.6 Menu 500 UPS Settings

500 UPS Settings	
This menu contains the electrical settings for the UPS functionality.	
Parameter:	**520 Max Autonomy Period**
Function:	Sets the maximum time the PCS100 UPS-I can correct a surge or sag
Access:	Operator
Range:	0 to 60,000. 0 = infinity
Units:	ms
Factory Setting:	0
Notes:	Prevents the PCS100 UPS-I from supplying power continuously under no load conditions.
	Parameter used to meet UL safety requirements for UPS implementations that do not have an input contactor. For a PCS100 UPS-I without an 'SCR off' detection board this parameter must be set to 15 seconds or less if UL safety requirements are to be met.
Parameter:	**521 Walk in Time**
Function:	Sets the time period over which the PCS100 UPS-I will softly transition load to a generator
Access:	Tech
Range:	0 to 8,000
Units:	ms
Factory Setting:	0
Setting up:	Set to an appropriate time to allow the generator to take up the load. For applications with no generator set to "0".
Note:	Required for integrating with auxiliary generators.
Parameter:	**530 RMS Sag Threshold**
Function:	Low RMS voltage deviation threshold below which the PCS100 UPS-I will transfer the load to the backup energy storage
Access:	Operator
Range:	0 to 200%
Units:	% (base = Parameter **121 Utility Voltage**)
Factory Setting:	90%
Note:	If the input RMS voltage falls below this value the PCS100 UPS-I will transfer to backup storage. Response time is about one half cycle i.e. 10 ms for a 50 Hz supply or 6.2 ms for 60 Hz.
Setting up:	Set to the lowest supply variation that the load can withstand. If adjusted too fine the PCS100 UPS-I will switch to the energy storage unnecessarily and there will be less storage available during critical sags.
Parameter:	**531 RMS Surge Threshold**
Function:	RMS high voltage threshold above which the PCS100 UPS-I will transfer the load from the utility to the backup energy storage
Access:	Operator
Range:	0 to 200%

Units:	% (base = Parameter **121 Utility Voltage**)
Factory Setting:	110%
Note:	If the input RMS voltage raises above the value of this parameter the PCS100 UPS-I will transfer to backup storage. Response time is about one half cycle i.e. 10 ms for a 50 Hz supply or 6.2 ms for 60 Hz
Setting up:	Set to the highest supply variation that the load can withstand. If adjusted too fine the PCS100 UPS-I will switch to the energy storage unnecessarily and there will be less storage available during critical surges.
Parameter:	**533 Frequency Limit**
Function:	Specifies the acceptable frequency limits for the utility supply
Access:	Operator
Range:	0 to 100%
Units:	% (base = Parameter **122 Utility Frequency**).
Factory Setting:	+/-5%
Note	Frequency detection typically is only used on generator supplies where the frequency can vary widely. The default threshold setting is such that the detection will not be triggered when connected to a grid.
Parameter:	**534 Transient Value**
Function:	Displays the present level of instantaneous voltage
Access:	Tech (Read-only)
Range:	+/- 100%
Units:	% (base = Parameter **121 Utility Voltage** (instantaneous))
Note:	Updates when entering the menu.
Parameter:	**535 Transient Threshold**
Function:	Sets the maximum instantaneous voltage error threshold beyond which the PCS100 UPS-I will switch the load from the utility to the energy storage (fast response)
Access:	Operator
Range:	0 to 200
Units:	% (base = Parameter **121 Utility Voltage** (instantaneous))
Factory Setting:	20%
Note:	This is an instantaneous voltage error detection designed to detect sub cyclic (or transient) errors in the supply voltage. It provides a more rapid response but more coarse detection than the RMS detection. The response time is about 1.1 ms. 
Setting up:	20% is an average setting. 30% may be required in the presence of notching or other high order harmonics. Refer to document 2UCD120000E014.

Parameter:	**536 Transient Filter**	
Function:	Specifies the time-constant of the transient detection filter	
Access:	Tech	
Range:	0 to 50	
Units:	ms	
Factory Setting:	1.186	
Setting up:	Refer to document 2UCD120000E014	
Parameter:	**540 Auto Start**	
Function:	Selects the PCS100 UPS-I automatic start up method after a power up	
Access:	Tech	
Range:	Name	Description
	No	PCS100 UPS-I never automatically starts
	Mem	PCS100 UPS-I remembers the start status at power down and applies the same status after power up
	Always	PCS100 UPS-I always automatically starts
Factory Setting:	Mem	
Note:	The remote start/stop terminals can override these settings	
Parameter:	**541 Start Command**	
Function:	Selects how a GDM start command and a start command via the Remote terminals on the front of the master module work together. (A stop command will always have priority)	
Access:	Tech	
Range:	Name	Description
	Local has Priority	Local control refers to the GDM. A GDM operator can override an active Remote start signal by pressing the GDM stop button. This causes the PCS100 UPS-I to trip (fault code 106). The GDM reset button will cause the system to start if a Remote start signal is still present.
	Remote has Priority	The Remote start input is level sensitive. When a Remote start signal is active in this mode, the stop button is removed from the GDM display so a GDM operator cannot override an active Remote start command.
	Edge Sensitive	In this mode the Remote start input is edge sensitive. The PCS100 UPS-I will start when the start input transitions from open to closed. The GDM start button can also start the PCS100 UPS-I.
Factory Setting:	Local has Priority	
Note:	See section **Error! Reference source not found.** for a description of the remote inputs.	

Table 10-7: Menu 500 UPS Settings parameters

10.3.7 Menu 600 Tests

Menu 600 Tests	
Parameter:	**611 Test Fan**
Function:	Forces the PCS100 UPS-I inverter cooling fans to switch on for the set time period
Range:	0.0 to 16383.5
Units:	Minutes
Factory Setting:	0.0
Access:	Operator
Parameter:	**612 Discharge – UD open**
Function:	Forces the PCS100 UPS-I to switch to the energy storage with the utility disconnect open for the set time period
Range:	0 to 520 Max Autonomy Period
Units:	ms
Factory Setting:	0
Access:	Tech
Note:	This test produces the same effect as when the utility voltage thresholds (parameters **530**,**531** and **532**) are exceeded
Parameter:	**620 Discharge – UD closed**
Function:	Forces the PCS100 UPS-I to switch to the energy storage with the utility disconnect closed for the set time period
Range:	0 to 327,680
Units:	ms
Factory Setting:	0
Access:	Tech
Note:	The purpose of this test is to test the ultracapacitors or batteries at a current level not determined by the load. The current during this test is set by **621 Discharge – UD closed**. The discharge will end if the utility voltage thresholds are exceeded. Below about 610 VDC the current waveform may become distorted.
Parameter:	**621 Discharge Level**
Function:	Sets the current request for use with **620 Discharge – UD closed**
Range:	10% to 100% of **122 System Current**
Units:	Amperes
Factory Setting:	30%
Access:	Tech
Note:	The discharge level sets the AC current level. The DC current will vary depending on voltages. Because this test feeds current into the utility which is low impedance the inverters are in current control mode and the accuracy of the current may be reduced.

Parameter:	**622 Discharge Min DC**
Function:	Sets the DC voltage that will end the **620 Discharge – UD closed** test.
Range:	0 to 1000
Units:	Volts
Factory Setting:	605 Volts
Access:	Factory
Note:	Because the inverter currents become distorted while using the discharge test at lower voltages, a limit is placed on how low the test should discharge the energy storage.
Parameter:	**625 Force FSB Closed**
Function:	Forces the Fail Safe Bypass closed
Range:	True / False
Factory Setting:	False
Access:	Tech
Note:	Only for use with systems that do not include maintenance bypass.
Parameter:	**630 Generate Event**
Function:	Generates a protection event (warning/fault/info)
Range:	0 to 32767
Factory Setting:	0
Access:	Tech
Note:	This should only be used as a part of the commissioning process. The PCS100 UPS-I should be offline and in bypass. Generating a fault event will cause the PCS100 UPS-I to go offline. The status bar will display the triggered event, the event log will log the event (event type 'Force'), and the status will be available via MODBUS. Warnings will be active for 10 seconds. Faults will require resetting using the GDM or digital inputs. To generate a system event, enter the event number. To generate an event for a module, multiply the module number by 1000 then add the event number. For example, to generate a 'VCAN error' (code 68) on module 3, enter a value of 3068 for this parameter. Module faults will result in a reduced capacity warning on the status bar. The respective module will flash 'E0' and the OK LED will flash.

Table 10-8: Menu 600 Tests

10.3.8 Menu 700 Charger Settings

700 Charger Settings	
Parameter:	**710 Charging Mode**
Function:	Sets which chargers will operate
Range:	None, Float, Module, Both
Factory Setting:	Both
Access:	Tech
Parameter:	**711 Charging Current**
Function:	Sets the current level during charging
Range:	0 to 40%
Units:	% of the PCS100 UPS-I rated current
Factory Setting:	10% for battery systems, 20% for Ultracapacitors
Access:	Factory
Note:	Because charging feeds power into the energy storage (Ultracapacitors or batteries) which have low impedance the inverters are current controlled and the accuracy of the current may be reduced.
Parameter:	**715 Force Float Charger On**
Function:	Forces the Float Charger on.
Range:	0 to 60
Units:	Minutes
Factory Setting:	0
Access:	Tech
Note:	This should only be used to assist maintenance work, such as when measuring battery balance or reconnecting a discharged capacitor enclosure.

Table 10-9: Menu 700 Charger Settings

10.3.9 Menu 800 Status-Currents

800 Status-Currents	
This menu contains current measurements. Will be updated when entering the menu.	
Parameter:	**810 Utility L1**
Function:	Displays the Utility RMS current in Line 1
Units	Amperes
Note:	Current detected by CTs fitted in the utility disconnect enclosure.
Parameter:	**811 Utility L2**
Function:	Displays the Utility RMS current in Line 2
Units	Amperes
Note:	Current detected by CTs fitted in the utility disconnect enclosure.
Parameter:	**812 Utility L3**
Function:	Displays the Utility RMS current in Line 3
Units	Amperes
Note:	Current detected by CTs fitted in the utility disconnect enclosure.
Parameter:	**813 Coupling Transformer L1**
Function:	Displays the coupling transformer RMS current in Line 1
Units	Amperes
Note:	Current detected by CTs fitted in the coupling transformer primary (delta) winding.
Parameter:	**814 Coupling Transformer L2**
Function:	Displays the coupling transformer RMS current in Line 2
Units	Amperes
Note:	Current detected by CTs fitted in the coupling transformer primary (delta) winding.
Parameter:	**815 Coupling Transformer L3**
Function:	Displays the coupling transformer RMS current in Line 3
Units	Amperes
Note:	Current detected by CTs fitted in the coupling transformer primary (delta) winding.
Parameter:	**816 Coupling Transformer N**
Function:	Displays the calculated RMS current in the coupling transformer neutral
Units	Amperes
Note:	Calculated from the sum of the instantaneous currents measured by the CTs in the delta windings of the coupling transformer.

Table 10-10: Menu 800 Status-Currents

10.3.10 Menu 900 Commissioning

Menu 900 Commissioning	
This menu contains parameters only used during commissioning or advanced setup.	
Parameter:	**905 GDM Remote Menus**
Function:	Enables remote access to the GDM menus via the GDM Ethernet connection
Access:	Tech
Note:	If enabled, allows an operator to remotely configure the PCS100 UPS-I.
Parameter:	**915 Relay Test Mode**
Function:	Turns relays on and off
Range:	7 test options
Factory Setting:	Off
Access:	Tech
Parameter:	**916 RMS Line Gnd Test**
Function:	Changes status page voltage readings from L-L to L-G
Range:	True / False
Factory Setting:	False
Access:	Tech
Note:	Used for calibration of voltage sensors
Parameter:	**919 Disconnect**
Function:	Selects any of the various test modes for the Utility Disconnect
Range:	Normal: SCR Conducting. SCR Open MAY DROP LOAD
Factory Setting:	Normal.
Access:	Tech.
	**CAUTION** The load may be dropped if this parameter is set incorrectly
Parameter:	**920 CESE**
Function:	Selects the CESE version
Range:	Unknown, CESE Mk1, CESE Mk2
Factory Setting:	Set to match the CESE hardware version
Access:	Tech
Note:	If fault code 42 “Initialisation Failure” occurs while the inverters are displaying L0 check the SCM status (refer to document 2UCD200000E430). Cycle power. Ensure that the CESE version is set to match the hardware version installed.

Table 10-11: Menu 900 Commissioning

10.3.11 Menu GDM A00 Display

GDM A00 Display	
The menu contains parameters to setup the graphic display module	
Parameter:	**A31 GDM Control Enable**
Function:	Enables or disables the local Start, Stop, Reset control
Range:	True / False
Factory Setting:	True
Access:	Operator
Note:	When disabled (false) the Start (I), Stop (0) and Reset button will not be displayed in the GDM.
Parameter:	**A62 Screen Saver Time**
Function:	Sets the time for the screen saver to activate
Range:	0 min to 999 min
Factory Setting:	15 min
Access:	Operator
Name:	**A63 SSH Port Enable**
Function:	Enables SSH access.
Range:	True / False
Factory Setting:	True
Access:	Operator
Name:	**A64 Firmware Upload Enable**
Function:	Enables firmware uploads
Range:	True / False
Factory Setting:	False
Access:	Operator

Table 10-12: Menu GDM A00 Display

10.3.12 Menu GDM B00 Network Settings

GDM B00 Network Settings	
This menu contains parameters to setup the GDM Ethernet port.	
Parameter:	**B11 Dynamic IP DHCP**
Function:	Configures the Dynamic Host Configuration Protocol (DHCP). This is displayed on the Product Page.
Range:	True = Dynamic, False = Static
Access:	Operator
Setting Up:	The network may be configured using either static or dynamic configuration methods. The static method is the simplest for a direct connection to a PC. The IP address for the GDM is manually configured via parameter **B12** below. The PC IP address in Windows may also need adjusting. The Dynamic method is when the computer's IP address is assigned automatically, in which case parameter **B12** and **B13** does not need to be entered. Dynamic IP addresses are most frequently assigned on LANs and broadband networks by a Dynamic Host Configuration Protocol (DHCP) server. On any but the simplest network the network administrator's assistance will probably be required. Parameter **B15 Apply Settings** must be set to TRUE to save this setting.
Parameter:	**B12 Static IP address**
Function:	Configures the GDM Static IP address
Range:	###.###.###.### (where ### = 1 to 255)
Access:	Operator
Setting Up:	Parameter **B15 Apply Settings** must be set to TRUE to save this setting. See section 12.2 for further setting up instructions.
Parameter:	**B13 Static IP mask**
Function:	Configures the Static IP mask
Range:	###.###.###.### (where ### = 1 to 255)
Access:	Operator
Setting Up:	Example: 255.255.254.0 Parameter **B15 Apply Settings** must be set to TRUE to save this setting. See section **Error! Reference source not found.** for further setting up instructions.
Parameter:	**B14 Static IP gateway**
Function:	Configures the Static IP gateway
Access:	Operator
Setting Up:	Parameter **B15 Apply Settings** must be set to TRUE to save this setting. See section **Error! Reference source not found.** for further setting up instructions.
Parameter:	**B15 Apply Settings**
Function:	Applies the network settings **B11**, **B12**, **B13** and **B14**. Select True to update the configuration.
Range:	True / False
Access:	Operator.
Setting Up:	To view the actual settings currently used by the PCS100 UPS-I see the Product Page in section 7.1.5. See section 12.2 for further setting up instructions.

Table 10-13: Menu GDM B00 Network Settings

10.3.13 Menu GDM C00 Network Status

GDM C00 Network Status	
This menu displays the network status for the GDM	
Parameter:	**GDM C200 Network Status**
Function:	Displays a range of Network settings
Range:	C11 Actual DHCP Active (true or false) C12 Actual IP Address, C13 Actual IP Mask, C14 Actual IP Gateway, C15 Mac Address C16 Ethernet Status (“Up” when active).
Access:	Read only
Function:	Useful for debugging network connection problems

Table 10-14: Menu GDM C00 Network Status

10.3.14 Menu GDM D00 Product Revision

Menu GDM D00 Product Revision	
This menu displays the various software revisions for the GDM	
Parameter:	GDM D300 Product Revision
Function:	Product & revision information about the GDM
Range:	D11 GDMIB Boot Product D12 GDMIB Boot Revision D13 GDMIB Product D14 GDMIB Revision D21 GDM Revision D31 Vcanserver name (should be “main-vcan_server”) D32 Vcanserver revision D40 Fan Control Service
Access:	Read only

Table 10-15: Menu GDM D00 Product Revision

11 EVENT CODES AND DESCRIPTIONS

Events, warning and faults for the PCS100 UPS-I are indicated via the GDM and recorded in the event log. A Summary of all the events, warning and faults are shown in Table 11-2: PCS100 UPS-I Event Descriptions. If the recommended action does not remedy the warning or fault then contact ABB for assistance. When contacting ABB a copy of the downloaded event log or service log will typically be required.

NOTICE – Trained Operators
All operations on the PCS100 UPS-I must only be carried out by a trained Operator familiar with the contents of this manual. Hazardous conditions could arise from incorrect adjustment.

Abbreviation	Description
F	Fault. A fault has occurred and the PCS100 UPS-I is in Bypass. The PCS100 UPS-I cannot be started until the fault is removed.
W	Warning. The PCS100 UPS-I is functioning normally but a warning condition exists.
S	The fault originated from the Auxiliary Master Module, Utility Disconnect, Float Charger or Fail-Safe Bypass.
I	The fault originated in a PCS100 Inverter module

Table 11-1: Key for abbreviations in Table 11-2

Code	Origin	Event Type	GDM Description	Event Description	Recommended Action
1	S, I	F	Module Start Failure	The module failed to start because of an error with one of the following: (1) The configuration ID does not match the hardware ID DIP switch. (2) NVRAM (3) FPGA (Field Programmable Gate Array)	Check the configuration ID
2	I	F	Desat	IGBT Desat Detection	Power down and restart PCS100 UPS-I. If the fault does not clear replace the relevant Inverter module.
3	I	F	Desat Cooling Time	A reset was attempted too soon after a Desat fault (event 02).	Wait for 30 s before pressing Reset.
4	S, I	System F Inverter W	LVDC PSU Voltage Low	(1) The PCS100 UPS-I has powered down. If intentionally powered down this warning is normal, and no resolution is required. (2) The LVDC power supply in the Auxiliary Master Module has failed.	(1) Check LVDC (26 V) power supply is 26.5-27 V (2) Check fuse F1 on the Auxiliary Master Module. (3) Check for approximately 200 VAC on P76. (4) Replace the relevant Auxiliary Master Module.
5	I	F	Interlock Error	The software has detected an error in IGBT gate triggers. Two of the IGBTs (Insulated Gate Bipolar Transistor) from the same bridge are turned on at one time. Only one should ever be turned on at any one time.	Replace the faulty Inverter module.
6	S, I	F	SPI Watchdog Error	There is an SPI (Serial Peripheral Interface Bus) watchdog error.	Ensure all communication cables are connected and not damaged. Replace any damaged cables. Replace the module reporting the Fault.
7	S, I	F	Combined FPGA Fault	There is a generic FPGA (Field-Programmable Gate Array) fault.	Check all communication cables.
8	I	W	DC Bus Overvoltage	The over voltage limit is set by the hardware in the Inverter module. Event code 148 “DC bus high” should occur before this fault and open the Coupling Transformer circuit breaker.	Power down and restart PCS100 UPS-I.
9	I	W	DC Bus Voltage High	The DC Bus voltage is high.	Wait until the DC voltage has returned to normal.

Code	Origin	Event Type	GDM Description	Event Description	Recommended Action
10	I	W	DC Bus Voltage Low	Energy Storage voltage is low.	If the charging function is operating (i.e., the DC voltage as indicated on the GDM is increasing) no action is required. The system will automatically recover when the Energy Storage recharges. The PCS100 UPS-I must be Online to enable the Float Charger. If the Float Charger is not working check the LEDs on the charger PCB
11	I	W	DC Bus Undervoltage	The Energy Storage voltage is too low to protect the load. Note: This fault is not recorded in the Event Log when the PCS100 UPS-I is offline.	If not already online start the PCS100 UPS-I and confirm that Energy Storage is charging. Note: The Float Charger is only enabled when the PCS100 UPS-I is online.
12	I	F	Zero Seq Current High	Inverter module zero sequence current is too high.	Check for earth faults on the Inverter side of the Coupling Transformer. A faulty Inverter module may need to be replaced.
13	I	F	Zero Seq Abs Current High	The PCS100 Module's absolute zero sequence currents are too high.	Check for earth faults on the Inverter side of the Coupling Transformer. A faulty Inverter module may need to be replaced.
14	I	F	Sync Lost Failure	The Inverter lost synchronization with Auxiliary Master Module.	(1) Check all communication cables. (2) Replace faulty module
15	I	F	Sync Lock T/O	The Inverter cannot synchronize with the Auxiliary Master Module within the timeout period.	(1) Check all communication cables. (2) Replace faulty module
18	S, I	W	Control Loop Timing	Sustainable internal condition.	Send the Service Log to the factory for assessment. If the warning persists power down and restart the PCS100 UPS-I.
19	S, I	F	Internal Error	There was an internal error.	Press Reset. If the fault is not resolved power down and restart PCS100 UPS-I.
20	S, I	W	Stack Level Warning	DSP stack has reached 75% threshold level.	Send the Service Log to the factory for assessment. If the warning persists power down and restart PCS100 UPS-I. Replace faulty module.
21	I	F	Contactor Activate T/O	The Inverter module pre-charge contactor has not opened within	Replace the faulty Inverter module.

				the required time-out period. This is detected by the auxiliary contacts on the pre-charge contactor inside the Inverter module.	
22	I	F	Contactor Deactivate T/O	The Inverter module pre-charge contactor has not closed within the required time-out period. This is detected by the auxiliary contacts on the pre-charge contactor inside the Inverter module.	Replace the faulty inverter module.
27	S	W	PLL Unlocked	This warning is displayed when: (1) The supply to the PCS100 UPS-I is switched off. (2) The Phase Lock Loop is not locked to the input voltage. (3) There was a +/- 20% frequency error.	Check the utility supply. Check the utility voltage sense connection and fuses.
31	S, I	F	FPGA Reset	The FPGA has been reset by an unidentified source.	Press Reset. If the fault is not resolved power down and restart PCS100 UPS-I.
35	S	F	SCR Not Off Timeout	The SCR short circuit detection hardware in the Utility Disconnect detected that an SCR did not open.	(1) Check the SCRs have no short circuit. (2) Ensure that the PCS100 UPS-I is not mechanically bypassed. (3) Check connections to/from the SCR short circuit detector in the Utility Disconnect. (4) Check the cables connecting to P42 on 0390-643. (5) Check the cables making their way back along P150 from 0390-643 to 0390-642. (6) Check the connection between P189 on 0390-656 and P169 pins 7-8 on 0390P646/648.
38	I	W	Out of Regulation Warning	Inverter output voltage out of regulation.	No action required.
39	I	F	Out of Regulation Error	Inverter output voltage out of regulation.	The module may need to be replaced.

Code	Origin	Event Type	GDM Description	Event Description	Recommended Action
40	I	F	SDI Cmd Error	Streaming Data Interface error.	Press Reset. If a restart does not resolve this warning obtain PCS100 UPS-I Service Log and send to the factory for assessment.
42	S	F	Initialisation Failure	A parameter is out of range.	If this fault occurs while the inverters are displaying L0 check the SCM status (refer to document 2UCD200000E430). Cycle power.
43	S	F	Fault Reset Timeout	(1) The Auxiliary Master Module was not able to reset a fault in an Inverter module. (2) All modules have not confirmed a reset that is part of the startup sequence within 500 ms.	Obtain the Service Log and send to the factory for assessment. Ensure all communication cables are connected and not damaged. If there is no damage power down and restart PCS100 UPS-I.
44	S	F	Parameter Error Downstream	The Auxiliary Master Module could not set a parameter in the modules.	Obtain the Service Log and send to the factory for assessment. Ensure all communication cables are connected and not damaged. If there is no damage power down and restart PCS100 UPS-I.
46	S	W	Inverter Unbalanced	There is a variation in current level between Inverter modules above threshold.	Check all Inverters are operating (powered up and displaying the module address on the digital display). Check for loose AC connections.
49	I	W	HW Current High	The short duration transistor current is too high. Note: The limit set by the hardware.	Replace the module.
50	I	F	HW Overcurrent	The long-duration transistor is over current. This may be caused by a short circuit in the load. Note: The limit is set by the hardware.	Replace the module.
51	I	W	Current Limit	The Inverter’s current exceeds 110% of its rating.	Reduce the load’s current to maintain full protection.
53	S	W	System HW Overcurrent	The load’s current exceeds the rating of PCS100 UPS-I. There may be short term transient over currents. Note: The limit is set by the hardware.	Ensure that the load is suitable for the PCS100 UPS-I.
54	S	W	System Current High	The load current is near the limit. Note: The limit is set by the software.	Reduce the load’s current to maintain full protection.

55	I	F	Sine Filter Over Temp	The PTC (Positive Temperature Coefficient thermistor) in module sine filter reactor indicates temperature is too high.	Ensure all module fans are operating. Ensure the ambient temperature is not too high.
56	I	W	Heatsink Hot	The Inverter's heat sink is hot. Note: A sensor is mounted on the heat sink.	Ensure all module fans are operating. Ensure the ambient temperature is not too high.
57	I	F	Heatsink Over Temp	The Inverter's heat sink is too hot. Note: A sensor is mounted on the heat sink.	Ensure all module fans are operating. Ensure the ambient temperature is not too high.
58	I	W	Enclosure Hot	The Inverter Enclosure's internal temperature is hot (near limit). Note: The temperature is monitored by a temperature sensor in enclosure.	Ensure all module fans are operating. Ensure the ambient temperature is not too high.
59	I	F	Enclosure Over Temp	The Inverter Enclosure's internal temperature is too hot (over the limit). Note: The temperature is monitored by a temperature sensor in enclosure.	Ensure all module fans are operating. Ensure the ambient temperature is not too high.
62	I	W	Transistor Junction Hot	The IGBT junction is hot (near limit). Note: The temperature is calculated using a thermal model.	Ensure all module fans are operating. Ensure the ambient temperature is not too high.
63	I	W	Copper Hot	The reactor winding is hot (near limit). Note: The temperature is calculated using a thermal model.	Ensure the PCS100 UPS-I is not overloaded and configured too sensitively. Ensure that the module charger parameters have not been adjusted.
64	I	F	Copper Over Temp	The reactor winding is too hot (over the limit). Note: The temperature is calculated using a thermal model.	Ensure the PCS100 UPS-I is not overloaded and configured too sensitively. Ensure that the module charger parameters have not been adjusted.
66	S	F	Transformer Hot	Transformer is too hot. Note: The temperature is detected by a thermistor in transformer winding.	Ensure the ambient temperature is not too high. Reduce utility voltage imbalance and harmonics.

Code	Origin	Event Type	GDM Description	Event Description	Recommended Action
67	S, I	W	VCAN Warning	An excessive number of communications retries.	Ensure all communication ribbon cables are connected and not damaged. Check for newly installed equipment nearby on the same electrical network.
68	S, I	F	VCAN Error	There was a non-recoverable communications error between the Auxiliary Master Module and the Inverter.	Ensure all communication ribbon cables are connected and not damaged.
70	S	W	Inverter Lost	The Auxiliary Master Module lost communication with the Inverter module. The Inverter module will be removed from the network by the redundancy function. To reinstate the module once the fault has been rectified a full system reboot must be performed via parameter 051 System Reboot.	Ensure all communication ribbon cables are connected and not damaged. Check the Event Log for other events for the same module.
71	I	F	Master Lost	The Inverter lost communication with Auxiliary Master Module.	Ensure all communication ribbon cables are connected and not damaged.
72	I	W	Module Comms Warning	Frames have been lost from the Streaming Data Interface from the Auxiliary Master Module	Ensure all communication ribbon cables are connected and not damaged.
73	I	F	Module Comms Fault	Streaming Data Interface frame loss exceeds the threshold. This is the Inverter reporting it is not receiving the messages from the Auxiliary Master Module.	Ensure all communication ribbon cables are connected and not damaged.
77	I	W	Module Address Changed	An Inverter module number has changed since power-up.	Check that the module address selector has not been set in between numbers.
79	I	W	Module Display Warning	There are sustainable communication errors between the module display board and Digital Signal Processor Engine (DSPE).	Replace the faulty module and return it to the factory for repair.
80	I	F	Module Display Error	There were unsustainable communication errors between the module display board and the Module DSPE (Digital Signal Processor Engine).	Replace the faulty module and return it to the factory for repair.
81	I	W	Inverter AC Voltage Low	The PCS100 UPS-I input voltage is below the operation threshold. Note: This is normal when the input voltage is removed or applied.	Check the Event Log for other faults or warnings reported from the same module.

83	S	F	IOM Testmode	Commissioning test mode has been activated through parameter: 915 Relay Test Mode	Disable IOM relay test mode.
84	S	F	Negative Phase Rotation	Negative phase rotation detected	Check the input phases are wired to the correct input
86	S,I	F	Not Passed Tester	This fault occurs when a module has: (1) not passed the factory test or (2) failed since leaving the factory.	Replace the faulty module.
87	S,I	F	IRQ Frequency Error	Software task IRQ not occurring at correct frequency.	(1) Send Service Log to the factory for assessment (2) Replace the module
88	S	F	Serial Number Error	The system (product) serial number is invalid.	Replace the Auxiliary Master Module auxiliary module as a complete unit.
90	I	W	Heatsink Cold	Inverter heatsink temperature sensor error or too cold.	(1) Check ambient temperature. (2) Replace the module.
91	I	W	Enclosure Cold	Inverter Enclosure temperature sensor error or too cold.	(1) Check ambient temperature. (2) Replace the module.
93	S	F	SCR Stack Failure	The SCR (Silicon Controlled Rectifier) firing board has detected an absence of SCR trigger current. Note: This fault does not reset itself. Note: When this fault occurs LED 2 on the Utility Disconnect interface board and LED 12 on the SCR firing board extinguishes.	Check the LEDs on the SCR firing board to narrow down the source of the problem (see the Service guide document number 2UCD120000E409).Check SCR gate wiring. Check SCRs. Replace SCR firing board. Check the severe-over-temperature sensor and connection.
106	S	F	Stop Button Override	The following scenario has occurred: (1) Parameter 541 Start Command is set to “GDM has Priority” and (2) The GDM’s Stop button is pressed when the PCS100 UPS1-I is started from another location e.g. control room. Note: This sequence of events causes a trip.	Press the Reset button and press “yes” at the confirmation screen to reset the fault.
108	I	F	RFI Lead Misconfiguration	Wrong module present in system.	Check the part number of the Inverter is correct for this machine.

Code	Origin	Event Type	GDM Description	Event Description	Recommended Action
109	I	F	Protection Message Error	Module cannot communicate with Auxiliary Master Module.	Check VCAN cables and connections
123	S	F	SCR Failed to Switch Off	The current through the SCRs had not reduced to zero after the SCRs were commanded to switch off.	(1) Check the SCR disable signal is being received from the Auxiliary Master Module as indicated by LED 1 in the Utility Disconnect by manually disabling the SCRs using parameter 919 while offline. (2) Replace faulty SCR
124	S	F	Input-Output Voltage Mismatch	A SCR input and output voltage mismatch is detected. This fault is triggered if these voltages differ more than the threshold while the SCR is on.	(1) Check the input/output voltage sensing and voltage sense fuses in the Utility Disconnect. (2) Check the LEDs on the SCR firing board to narrow down the source of the problem (see the Service guide document number 2UCD120000E409). (3) Check and manually reset the hardware severe-over-temperature sensor (120°C) located on the top SCR heatsink. (4) Check SCR gate wiring. Check SCRs. Replace SCR firing board.
125	S	Info	System Stop	This message indicates a state change to “Bypass” but it does not indicate what caused the state change. Events 210 to 212 indicate the source of the state change.	Info only
126	S	Info	System Starting	The PCS100 UPS-I has received a start command and the PCS100 UPS-I status changed to Starting. Normally the PCS100 UPS-I will quickly go to “Online”. This message indicates a state change to “Starting” but it does not indicate what caused the state change. Events 210 to 212 indicate the source of the state change.	Info only
127	S	Info	Discharge - rms	The load has transferred to the PCS100 UPS-I Energy Storage due to the utility RMS voltage being out of limits.	Info only
128	S	Info	Transfer Back	The PCS100 UPS-I is synchronizing with the utility before it connects.	Info only

129	S	Info	Online	The PCS100 UPS-I is ready to take over the load in the event of a utility failure.	Info only
130	S	Info	Discharge T/O	The maximum autonomy period has been exceeded and the PCS100 UPS-I will transfer back to the Utility.	Info only
131	S	Info	Inverter Off		
132	S	Info	End Of Discharge	The Battery or Ultracapacitor Energy Storage is discharged. Wait for them to recharge.	Info only
133	S	Info	Discharge Overload	A hardware over current or heating hot event has occurred during a discharge event.	
134	S	Info	Mains Lost Again	The utility exceeded the voltage thresholds while the PCS100 UPS-I's Inverter was trying to synchronize back to the utility.	Info only
135	S	Info	Test Mode	A test mode has been activated.	Info only
137	S	W	Load Current High	The load current exceeds 100% of the PCS100 UPS-I rating.	Reduce the load current to maintain full protection.
139	S	W	Special Disconnect Mode	A test mode was selected for testing the Utility Disconnect and has not been deselected. Note: 919 Disconnect Mode NOTICE! Test Mode Do not leave the PCS100 UPS-I in test mode. Leaving the PCS100 UPS-I in test mode after testing is competed can damage the PCS100 UPS-I.	Ensure all test modes are deselected.
144	S	F	Tx CB Tripped	The Coupling Transformer circuit breaker has been tripped. Note: The software may trip the circuit breaker in response to another fault.	Check the Event Log for the reason why the CB has opened. Remedy the problem. Reset (close) the circuit breaker.
145	S	F	SCR Hot	The SCR (Silicon Controlled Rectifier) heat sink is too hot (90°C). Note: When this fault occurs, the Utility Disconnect status LED4 is off (not illuminated).	Ensure all module fans are operating and ensure there are no obstructions to the airflow.

Code	Origin	Event Type	GDM Description	Event Description	Recommended Action
146	S	W	Energy Storage Warning	MkI Energy Storage Enclosures. (1) There is a fault with the Float Charger. (2) The Energy Storage Enclosure is too hot. (3) A battery/Ultracapacitor is over voltage. (4) The Float Charger's circuit breaker (in the Coupling Transformer Enclosure) is tripped.	Check the LEDs on the float charger PCB to narrow down the cause of the warning problem (see the Service guide document number 2UCD120000E409). If the Energy Storage Enclosure is hot check that the fans are operating. If the battery/Ultracapacitor is over voltage investigate the causes of the voltage anomaly. If the circuit breaker has tripped investigate the cause of the trip.
148	S	W	DC Bus High - CB Tripped	The DC Bus voltage is too high which causes the Coupling Transformer's circuit breaker to trip.	Check the integrity of the transformer and the primary transformer cables.
149	S	W	Tx Zero Seq Current High	The zero-sequence current (or neutral current) in the Coupling Transformer is high. The zero-sequence current is measured by summing the 3 phase currents measured by the CTs in the Coupling Transformer primary.	(1) Check the load current imbalance. (2) Check the source voltage imbalance. (3) Check the current measurements are accurate.
150	S	F	Tx Zero Seq I Too High	There are large zero sequence currents through the Coupling Transformer which could cause overheating of the transformer. This fault will trip the Coupling Transformer's circuit breaker. The zero sequence current is measured by summing the 3 phase currents measured by the CTs in the Coupling Transformer primary.	Reduce the load or utility imbalance then reset (close) the circuit breaker. The Coupling Transformer current measuring circuit may need checking.
173	S	F	Output Volt Too Low	Output RMS line to line voltage is low for too long	Check for external faults in the load
191	S	W	Reduced System Capacity	There is a problem with one or more of the Inverter modules or a module has a DC voltage less than 650 Vdc.	Check Event Log. Replace faulty module.
196	S	W	DC Breaker Tripped	For Battery and MkI Energy Storage Enclosures. A main DC circuit breaker has been tripped. Note: If the PCS100 UPS-I has additional healthy Energy Storage Enclosures it can still operate but at reduced capacity. The DC circuit breaker cannot be tripped by the PCS100 UPS-I software.	Check the cabling of the Energy Storage Enclosures for short circuits to earth or other faults.

200	S	F	Redundancy trip	More than 50% of the Inverters have faults.	Replace the faulty Inverter modules.
201	S	W	Unbalanced dcbus	The DC bus voltage from mid-bus to ground is outside the threshold of 40V. There may be a ground fault on the DC.	Check for ground fault on DC bus / Energy Storage.
202	I	F	Transistor Junction OverTemp	Inverter Transistor Junction maximum operating temperature has been reached.	(1) Check all module fans are operating correctly and ambient temperature is not too high. (2) Check Event Log for additional faults/warnings (over current).
204	S	F	Dcbus center ripple high	There is high ripple voltage on the Inverter DC bus	Check for an earth fault between the Inverter AC output and the Coupling Transformer.
209	S	Info	Reboot	A reboot has been requested which effectively power cycles the Auxiliary Master Module.	If the user did not select reboot obtain the Service Log and send to the factory for assessment.
210	S	Start/ Stop/ Reset	Remote	A start or stop or reset command has been received by the terminals on the front of the Auxiliary Master Module. The “Inhibit Switch” inside the master inverter enclosure door will also initiate this event since it is connected to the Remote terminals.	Info only
211	S	Start/ Stop/ Reset	Local	A start or stop or reset command has been received from the GDM.	Info only
212	S	Start/ Stop/ Reset	Automatic	A Start, Stop, Reset command has been initiated by the Auxiliary Master Module or the PCS100 UPS-I Auxiliary Master Module has powered up or powered down.	Info only
218	S	Start/ Stop/ Reset	Remote webpage	A Mode change command has been received by the Remote Web Pages	Info only

Code	Origin	Event Type	GDM Description	Event Description	Recommended Action
221	S	W	Bypass not ready	Three things can produce this warning: 1. The FSB spring is discharged. 2. There is an under voltage on the FSB Interface Board. LED 3 will turn off while the under voltage is present and the Interface Board will autonomously close the FSB. The master will detect the un-commanded closure via the FSB aux contacts and will trigger event 325. 3. The SOR test device in the FSB enclosure has detected the ACB close coil resistance is out of tolerance. When this warning is present LED 5 on the utility disconnect interface board (see Table 7-11) and LED 7 on the SCR firing board will be off (not illuminated). The FSB will close while this Warning is present even if the PCS100 UPS-I is ON LINE. This warning is masked for the first 6 seconds it is active to allow time for the FSB spring to charge.	(1) View the window on the front of the ACB to see if the operating spring is charged. (2) View the FSB Interface PCB LED3 (ULVO). If it is off the PCB has detected a low DC voltage supply and has commanded the ACB to close. Check the LVDC power supply to the FSB interface board is above the threshold (23Vdc) (3) View the Fault LED on the SOR test unit.
222	S	Info	Discharge - transient	The utility's transient voltage threshold has been breached and the PCS100 UPS-I has: (1) begun supplying the load from the PCS100 UPS-I's Energy Storage and (2) disconnected the load from the utility.	Info only
223	S	Info	Discharge - test	A test discharge has been performed using parameter 622 Test Activate.	Info only
225	S	Info	Module Charger	The Module Charger has changed state (on/off).	Info only
283	I	F	Many contactor activations	The Inverter pre-charge contactor is switching too often.	Check Event Log for primary cause.
285	I	F	Sequence Mismatch Error	A module has detected that its phase sequence differs from the Auxiliary Master Module.	Check grid voltage phase rotation is correct and check voltage sensing wiring.
307	S	Info	Discharge - frequency	The utility frequency has breached its threshold and the PCS100 UPS-I has:	Info only

				(1) begun supplying the load from the PCS100 UPS-I Energy Storage and (2) disconnected the load from the utility.	
308	S	Info	Emergency power off	Emergency power off switch activated	Info only
325	S	F	FSB On Timeout	The Fail-Safe Bypass (FSB) has not opened within the required time-out period or the FSB is closed when it should be open. This is detected by the auxiliary contacts inside the FSB. The 2200A and 4200A FSBs employ an ACB (air circuit breaker) fitted in a separate FSB enclosure. The 900A FSB employs normally closed contactors fitted in the utility disconnect module	For a 2200 or 4200 A FSB check: (1) If anyone manually closed the ACB. (the FSB open/closed status can be viewed via the window on the front of the ACB) (2) Check the ACB open coil. (3) Replace the FSB Interface board. (4) Check the ACB aux contact circuit. (5) Check if the FSB Interface Board has autonomously closed the FSB. See event 221 for more information. For a 900 A FSB, Replace the Utility Disconnect module.
326	S	F	FSB Off Timeout	The Fail-Safe Bypass (FSB) has not closed within the required time-out period or the FSB is open when it should be closed. Note: This is detected by the auxiliary contacts on the FSB. The 2200 A and 4200 A FSBs employ an ACB fitted in a separate FSB enclosure. The 900 A FSB employs normally closed contactors fitted in the Utility Disconnect module.	For a 2200 or 4200 A FSB check: (1) If anyone manually opened the ACB. (the FSB open/closed status can be viewed via the window on the front of the ACB) (2) Check the ACB close coil (3) Replace the FSB Interface board (4) Check the ACB aux contact circuit. For a 900 A FSB replace the Utility Disconnect module
327	S	W	FSB Forced Close	The FSB is currently being forced closed by the Test menu	Clear parameter 625 at the end of your testing

Code	Origin	Event Type	GDM Description	Event Description	Recommended Action
328	S	W	SCM Comms lost	The Auxiliary Master Module has failed to receive a response to a status request from the SCM.	(1) Check the Event Log for SCM errors. (2) Check the power supply to the SCM. (3) Check VCAN cables and connections between the Auxiliary Master Module and the SCM.
329	S	W	System Copper Hot	Coupling Transformer winding temperature is near its limit. Note: The temperature is calculated using a thermal model.	Ensure the load current does not exceed the PCS100 UPS-I specification.
330	S	F	System Copper Over Temp	Coupling Transformer winding temperature too hot (over the limit). Note: The temperature is calculated using a thermal model.	Ensure the load current does not exceed the PCS100 UPS-I specifications.
331	S	W	SCM fault	The System Configuration Module (SCM) has detected a fault in the SCM or the System.	Consult the factory.
332	S	Info	Master Reset	The Auxiliary Master Module has detected that it has received a reset.	If this event is preceded by a user-initiated system reboot then it can be ignored. Otherwise send the Service Log to the factory for assessment.
333	S	W	Float Charger Fault	The Float Charger has a fault. While not preventing the PCS100 UPS-I from operating once running, it will likely prevent it from restarting after a deep discharge and/or power cycle.	To identify the source of the fault, check the LEDs on charger's printed circuit board against Service guide document number 2UCD120000E409. If the charger circuit breaker has been tripped, investigate the cause of the trip.
334	S	W	Energy Storage Warning	Capacitor Energy Storage Systems. There is a warning in an Energy Storage Enclosure.	Refer to the Ultracapacitor Monitor Board Reference Card (document 2UCD000391E00016) and PCS100 UPS-I User Manual (2UCD120000E001)
336	S	W	UD Cooling Pressure Low	Low cooling pressure detected in the Utility Disconnect Enclosure.	Ensure the enclosure doors are closed and properly latched. Confirm input voltage and continuity of supply to the fan(s). Check, clean and/or renew filters. Confirm the fans are free to rotate. Replace fans if necessary. Confirm correct connection of pressure switch and tubing.

404	I	F	IGBT Gate drive Failure’	IGBT desaturation detected without the IGBT being switched. Desaturation is a failsafe fault, so this indicates a fault in the IGBT driving components.	Power down and restart. If the fault is not resolved contact your ABB Service Agent to have relevant module replaced.

Table 11-2: PCS100 UPS-I Event Descriptions

12 REMOTE MONITORING

The PCS100 UPS-I provides remote access for monitoring purposes. Following monitoring connections are available:

- Integrated Web server. Using the integrated web server, the same information as displayed on the GDM is available on any networked PC connected to the PCS100 UPS-I. In addition, downloading event and service information is possible from the integrated web server.
- Modbus TCP. For connection to plant wide SCADA or monitoring systems the PCS100 UPS-I has a list of registers that can be accessed.
- Email Connectivity. An email notification service can be set up to send notifications of power quality and system events

Communication Type	Description	Port	Connection
Remote Web Pages	Webserver via HTTP, Ethernet	80	Standard RJ45
	SW upgrade via SSH	22	Standard RJ45
Monitoring system	Modbus TCP	502	Standard RJ45
Remote notifications	E-mail		Standard RJ45

Remote Web Pages
Remote Web Pages are a set of web pages that are similar in format to the standard GDM and accessed through the integrated web server via the GDM Ethernet connection. Through this interface the users can remotely access the status and operating parameters. Viewing and downloading of event history and service logs is also available.
Access is via the Ethernet port of the GDM and web pages can be viewed any standard web browser on a device connected to the same network.
Note: for security reasons start/stop control and parameter menus are disabled by default. However, they can be enabled through parameter settings on the unit.

Modbus TCP
Modbus TCP connection is also provided via the Ethernet port of the GDM user interface.
Read Only access is available to operating parameters such as voltages, currents and power levels.

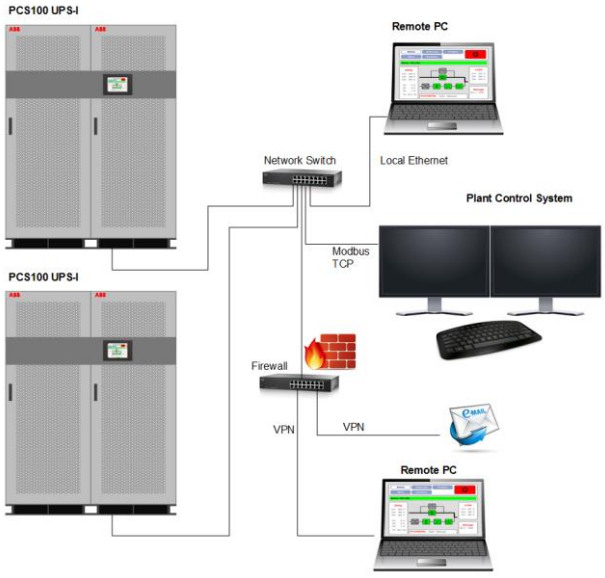


Figure 12-1: PCS100 UPS-I remote monitoring diagram

12.1 Cybersecurity

12.1.1 Cybersecurity Legal Disclaimer

This product is designed to be connected to and to communicate information and data via network interface. It is Customer's sole responsibility to provide and continuously ensure a secure connection between the product and Customer network or any other network (as the case may be). Customer shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc.) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

12.1.2 Deployment Guideline

This device shall be connected only to a private/restricted network and not to any public networks.
When connecting to public networks, security measures must be taken to reduce the cyber security risks. Such measures are not provided by the PCS100 product, “external equipment” is needed.
This private/restricted network can be connected for access via Internet or other network when using **“external equipment”**.
which can be separated devices or devices that combine **firewall, router, and secure VPN functionality**. The cyber security standard of these external equipment depends on the customer and the targeted security level.

CAUTION
This “Cybersecurity Deployment” guideline cannot suggest concrete products for **“external equipment”** to make a secure system setup. This must be decided along the specific project, requirements and existing infrastructure.

Recommendations
When commissioning a network system, it is important to address the cybersecurity problems by making a cybersecurity assessment of the system. Examples of methods to reduce security vulnerabilities include:

- **Network connection** Limit the connections with routers/firewall and similar products
- **Network access control** Add some control/limitations on the network using routers/firewall and similar products
- **Network monitor** If required, add products which can monitor the network access and traffic
- **Network separation** For cybersecurity and to protect the factory system, it is good to separate if from the remote connection gateway
- It is highly recommended to contact cybersecurity personnel/consultants to make an effective cybersecurity assessment of the factory system.

12.1.3 List of User/System Accounts in ABB delivery

Linux root account is only available as a service account used with SSH. SSH port is disabled by default, however, it can be enabled through parameter settings.

12.2 Remote Web Pages

The Graphical Display Module contains a set of web pages that are similar in format to the standard GDM pages described in section 7.1. They may be accessed via the Ethernet port of the GDM and viewed on a remote PC using any standard web browser.
The following pages are supported:

1 Status page
2 Event Log
3 Product page
4 Summary page
5 Service page
6 Menu page (if enabled via parameter **905 GDM Remote Menus**)

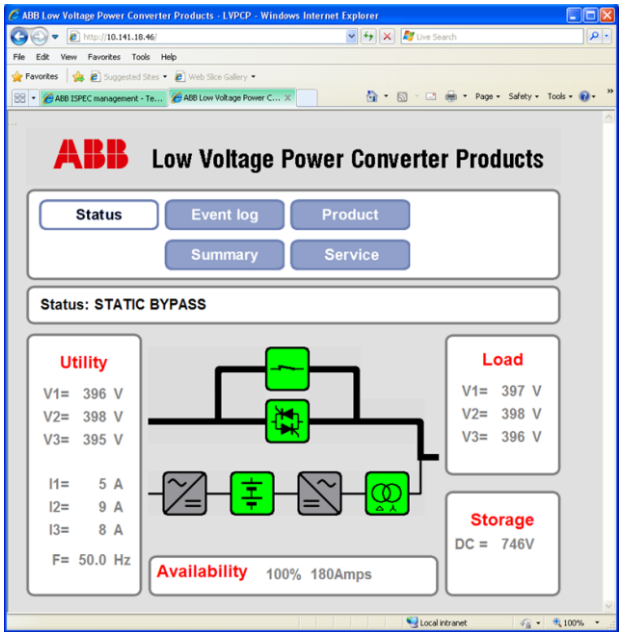


Figure 12-2: PCS100 UPS-I Remote Web Pages Status Page

Each page contains the navigation panel, and the status bar, and each page is accessed by clicking the buttons using a mouse.

Start (I)/Stop (O)/Reset functionality is only supported through these pages if remote menu access is enabled via parameter **A31 GDM Control Enable.**

12.2.1 Connecting the Network Connection.

To access the web pages, connect your PC to the Ethernet port on the bottom of the GDM using an Ethernet cable.

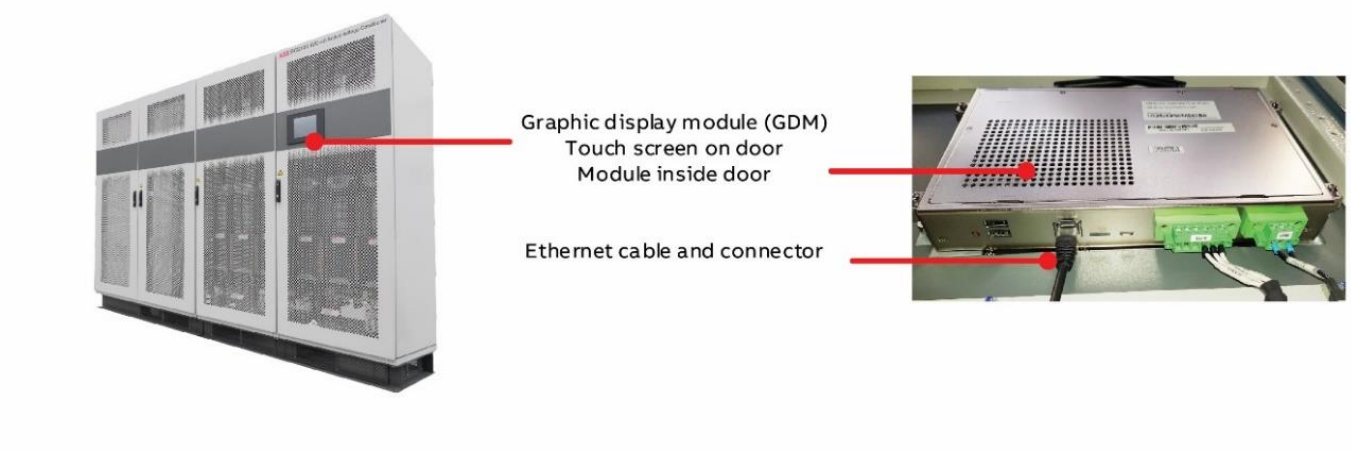


Figure 12-3: GDM Ethernet connector

Connecting a GDM directly to a computer using an Ethernet cable.

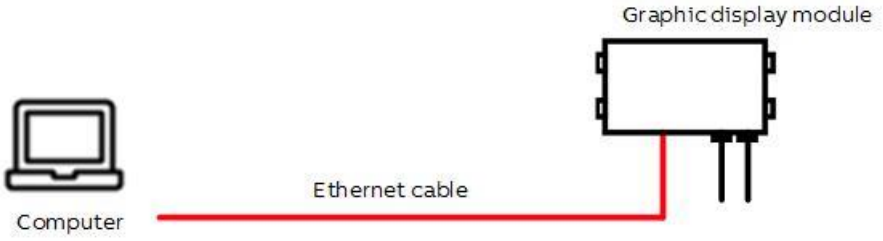


Figure 12-4: GDM Ethernet connection

You can connect one or more PCS100 UPS-I GDMs to a network using a Ethernet switch or hub and ethernet cables.

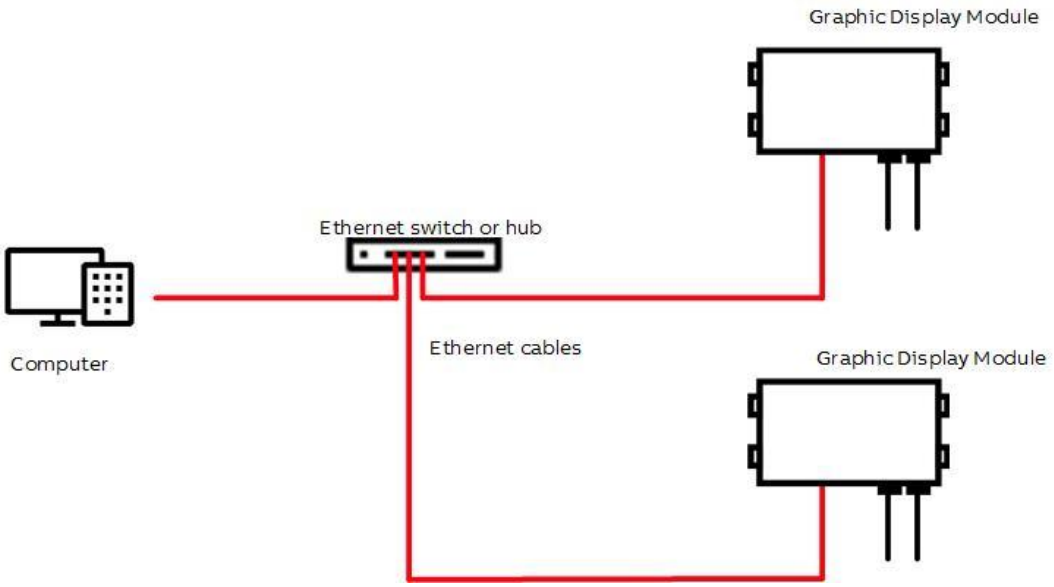


Figure 12-5: Multiple GDM connections

12.2.2 Configuring the Network Connection.

The Ethernet network is configured using parameters **B11** to **B15**. See section 10.3.12.

For a full description on how to configure the network connection see ABB document No. 2UCD20000E001 How to View the GDM Remote Web Pages.

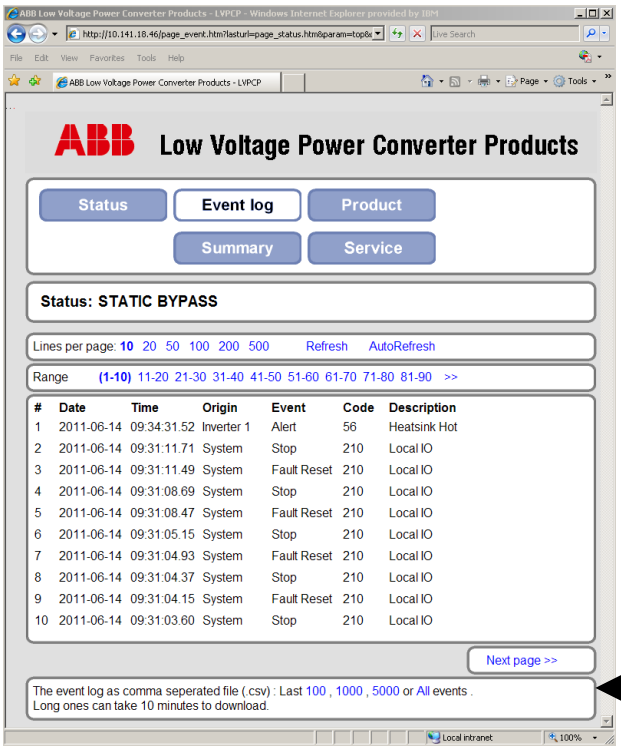
12.2.3 Connecting to Remote Web Pages

Enter the GDM IP address (as configured in See section 10.3.12.) in the address field of your PC web browser. Use the format http://##.###.##.## where ##.###.##.## is the IP address of the GDM.

12.2.4 Viewing and Downloading Event Log

Viewing and downloading of the event log is done by the Event Log Page.

Figure 12-5 shows a typical remote web pages event log. The number of lines per page and the range of events being view can be selected. Additionally the user is able to download the event log to PC. The last 100, 1000, 5000 or All events can be downloaded.



To download the event log to the connected PC click the number of events.

The downloaded event log is in .csv format and can be opened using Microsoft Excel. Each event is displayed on one line. See section **Error! Reference source not found.** for a full description of the event log.

12.2.5 Service Page

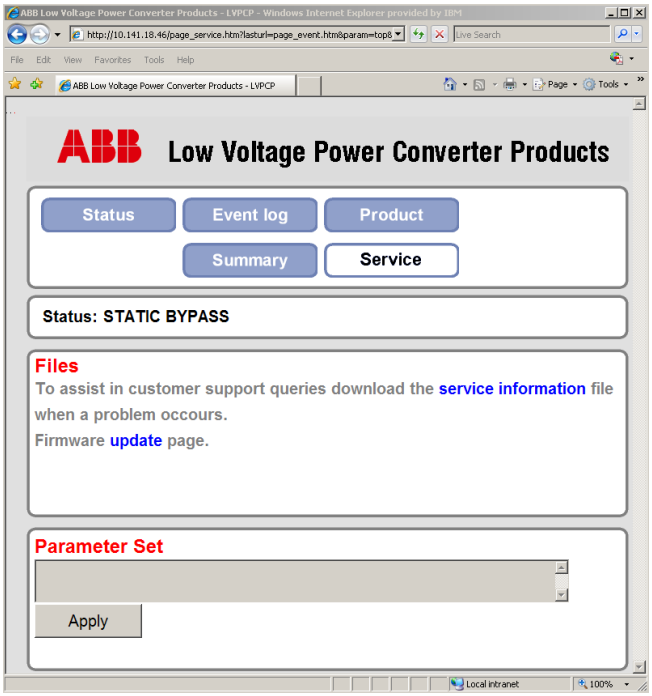


Table 12-1: Remote Web Pages Service Page

The Service Page has following three functions.

12.2.5.1 Download Service Information.

Information useful for the ABB service department such as parameter settings and the event log can be downloaded. The information is contained within a zip file which can be sent to the ABB factory to assist in analyzing problems with the product. To download this information:

a. Click Service Information Download. You will be informed that a service file is being created. Creating a service file is a five-step process. This may take some time, e.g., five minutes. You will then be informed that the service information is ready to download.
b. When prompted by your browser, save the file to the relevant location on your device.

12.2.5.2 Update the Product Firmware

Click Firmware Upload, then click Browse and select the software file provided by the ABB factory. The name of the software file typically starts with a 4 digit number beginning with 7. Once the file has down loaded the system must be rebooted via parameter 051 System Reboot.
For further information on upgrading software over Ethernet see document 2UCD200000E002_a How to Upgrade System Software over Ethernet.

12.2.5.3 Make a change to an internal parameter

Enter the factory supplied code to change the required internal parameter. When a correct code is entered the message "Parameter Write Result = OK" will be displayed. If an incorrect code is entered the message "Sorry, value entered is not correct" is displayed. This function is the same as parameter **53 Set Parameter**.

12.3 Modbus TCP

Modbus TCP connection is provided with PCS100 UPS-Is fitted with the GDM user interface. Connection is via an Ethernet cable to the Ethernet port on the bottom of the GDM. Read Only access is available to the parameters in Table 12-2: PCS100 UPS-I Modbus TCP user parameters

Modbus protocol is an open messaging structure developed by Modicon in 1979, used to establish master-slave (client/server) communication between intelligent devices. It is a de facto standard, truly open and the most widely used network protocol in the industrial manufacturing environment.

Modbus TCP specification (available from www.modbus-ida.org/specs.php) was developed in 1999, combining the physical network (Ethernet) with a networking standard (TCP/IP) and a vendor neutral data representation (Modbus) giving an open, accessible network for exchange of process data.

Modbus TCP basically embeds a Modbus frame into a TCP/IP frame in a simple manner.

12.3.1 Supported Functions

The following Modbus functions are supported:

- Function 3 – Read multiple registers
- Function 4 – Read input registers
- Function 8 – Diagnostic request

The Modbus server has the following characteristics:

Maximum registers per request	16
Maximum TCP connections	5
Modbus server port	502

Refer to section 10 for network configuration details. There are no additional Modbus TCP specific user parameters.

12.3.2 Performance

Each user parameter read for registers in Table 12-2 can take up to 300 ms due to the latency of the PCS100 internal communication bus. To improve Modbus client responsiveness (such as for use in SCADA systems), the Modbus TCP server caches a range of user parameters as specified in Table 12-3).

The Modbus TCP server responds to reads from the cached addresses in typically less than 3 milliseconds. However the latency in a parameter changing value (the time it takes for the cached values to be refreshed) is typically around 3 seconds.

12.3.3 Modbus TCP User Parameters

The following table lists the user parameters available from the PCS100 UPS-I.
The address listed is the offset (raw) address. For 4xxxx address add 40001 to the offset address. Each address refers to a 16 bit register.

Address	Name	Access	Type	Raw Value & Scaling
1	Product Status	Read Only	16-bit, Enum	0 – FAULT 1 – STOP 2 – STARTING 3 – RUN 4 – STOPPING 5 - BYPASS
2	Warning Indication (same as warning relay)	Read Only	16-bit, Enum	0 – NOT WARNING 1 – WARNING
3	Inhibit Indication (same as inhibit switch)	Read Only	16-bit, Enum	0 – NOT INHIBIT 1 – INHIBIT
4	Supply Voltage (same as parameter 121)	Read Only	16-bit, Signed	Voltage (line-to-line RMS Volts) = Raw value e.g., Raw value = 480 Voltage = 480 V
5	Supply Frequency (same as parameter 122)	Read Only	16-bit, Signed	f (Hz) = Raw value / 32 e.g., If the Raw value = 1920 the frequency = 60 Hz
6	System Current (Same as parameter 112)	Read Only	16-bit, Signed	Current (RMS Amperes) = Raw value e.g., Raw value = 500 Current = 500 A
7	Input Voltage V1-V2	Read Only	16-bit, Signed	Voltage (line-to-line RMS Volts) = Raw value x Sys base voltage / 8192 e.g., Raw value = 7782 Sys base voltage = 480V (parameter 121) Voltage (line-to-line RMS) = 456 V Voltage (% of rated voltage) = Raw value x 100 / 8192 e.g., Raw value = 8192 Voltage = 100%
8	Input Voltage V2-V3	Read Only	16-bit, Signed	
9	Input Voltage V3-V1	Read Only	16-bit, Signed	
10	Output Voltage V1-V2	Read Only	16-bit, Signed	
11	Output Voltage V2-V3	Read Only	16-bit, Signed	
12	Output Voltage V3-V1	Read Only	16-bit, Signed	
13	Load Current I1	Read Only	16-bit, Signed	Phase Current (RMS Amperes) = Raw value x rated current / 8192 e.g., Raw value = 5792 rated current = 500 A (parameter 112) Current = 354 A Current (% of rated current) = Raw value x 100 / 8192 e.g., Raw value = 4096 Current = 50%
14	Load Current I2	Read Only	16-bit, Signed	
15	Load Current I3	Read Only	16-bit, Signed	
16	Frequency	Read Only	16-bit, Signed	Frequency (Hz) = Raw value x Rated frequency / 8192 e.g., Raw value = 8192 Rated frequency = 60 Hz

				Frequency = 60.0 Hz
Address	**Name**	**Access**	**Type**	**Raw Value & Scaling**
17	Inverter DC Bus Voltage minimum	Read Only	16-bit, Signed	Voltage (Volts) = 480 * 0.816496 * Raw value / 8192 (Inverter module with min DC voltage)
18	Inverter DC Bus Voltage maximum	Read Only	16-bit, Signed	Voltage (Volts) = 480 * 0.816496 * Raw value / 8192 (Inverter module with max DC voltage)
19	Storage DC Voltage (Same as on Status page)	Read Only	1- bit, Signed	Voltage (volts) = 480 * 0.816496 * Raw value / 8192
20	Active Event Code (Same as GDM status line)	Read Only	16-bit, Signed	Refer to Table 11-2 for a list of event codes. Code 0 indicates there are no active events (no warning/fault)
21	Discharge Count	Read Only	16-bit, Signed	Discharge count = Raw value
22	Detailed Status	Read Only	16-bit, Signed	0 – System is initializing (Startup web page) 1 – Fault 2 - Clearing Fault 3 - Static Bypass 4 - Starting 5 - On Line 20 – Inverter Not ready (Starting - System Bypass state shown in the Figure 7-6 (state flow diagram)) 21 – Discharging 22 – Discharging (Wait for stable mains) 23 – Discharging (Synchronizing) 24 – Online 25 – Mains Lost while returning to mains. 26 – Discharge T/O 27 – Storage Empty 28 – Inverter Off (problem with inverter. FSB closed) 29 – Discharge Overload 30 – Test_Mode (UD Open test (menu 612) - refer to Figure 7-6) 31 –Walking in (28 Transfer Back - refer to Figure 7-6)
23	Read Test	Read Only	16 bit unsigned	Counts up by one for each access to this register. Can be used by Modbus masters to check connection.
100 &101	Date and Time (To read & set the date and time)	Read/Write	32bit Unsigned	Unit is seconds. Datum is 00:00:00 1/1/1970. e.g.: 1297296764 is 00:12:31 10/2/2011
102	Read/Write Test	Read/Write	16 bits	Register for use by customer for testing Modbus. Not used by PCS100 UPS-I
1000	Charger Mode	Read/Write	16 bit signed	0 – No charger control or monitoring 1 – Charging controlled via float charger 2 – Charging controlled via inverter modules 3 – Charging controlled via float charger and inverter modules

Table 12-2: PCS100 UPS-I Modbus TCP user parameters

Address	Name	Access	Type	Raw Value & Scaling
1001-1023	Cached registers 1-23 (see section 12.3.2)	Read Only	As for registers 1-23	Same as for registers 1-23

Table 12-3: PCS100 UPS-I Modbus TCP cached user parameters

12.3.4 Modbus TCP Error Codes

The following error codes may be returned by the Modbus TCP server.

Code	Name	Description
1	Illegal Function	Function code received in the query is not supported by this MODBUS server or the query is badly formatted.
2	Illegal Data Address	The data address received in the query is not a valid address in the MODBUS server. Specifically, the combination of address and number of registers is not valid. Register not known by the PCS100 UPS-I Register is not in MODBUS config table Not all registers of a single parameter accessed Register / length mismatch
3	Illegal Data Value	The value received in the query is not an allowable value for this register or the implied length is invalid. Value out of range for parameter Number of registers requested exceeds max.
4	Slave Device Failure	An unrecoverable error occurred while server attempted to perform requested action. Read/Write access violation GDM hardware issues Insufficient access privileges
6	Slave device Busy	The MODBUS server is unable to process this command at present. Retry this command again later. GDM VCAN server is busy, unavailable or has returned an error GDM VCAN cable has been unplugged from the GDM

Table 12-4: PCS100 UPS-I Modbus TCP error codes

13 WIRING

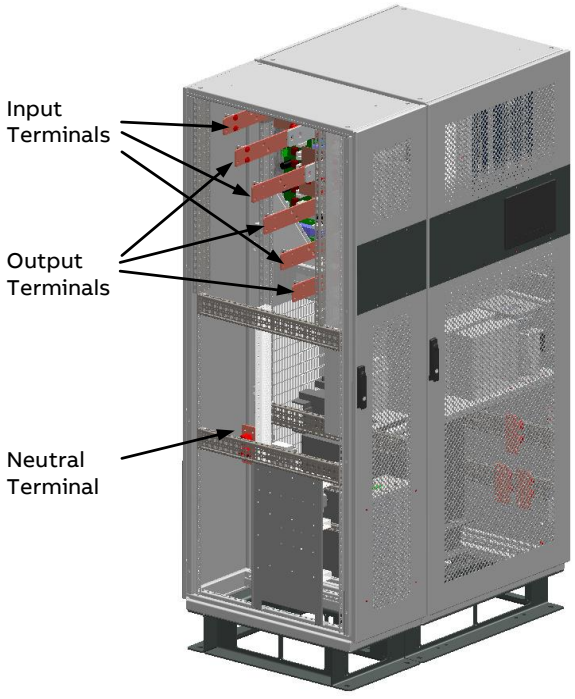
13.1 Power Connections

Following connections are required for the PCS100 UPS-I:

Terminal Label	Function
L1, L2, L3	Utility Supply (Input)
L1', L2' L3'	Load (Output)
N	Neutral

13.1.1 900 A Utility Disconnect

The PCS100 UPS-I systems with a 900 A Utility Disconnect have the main input and output connections on the left side.

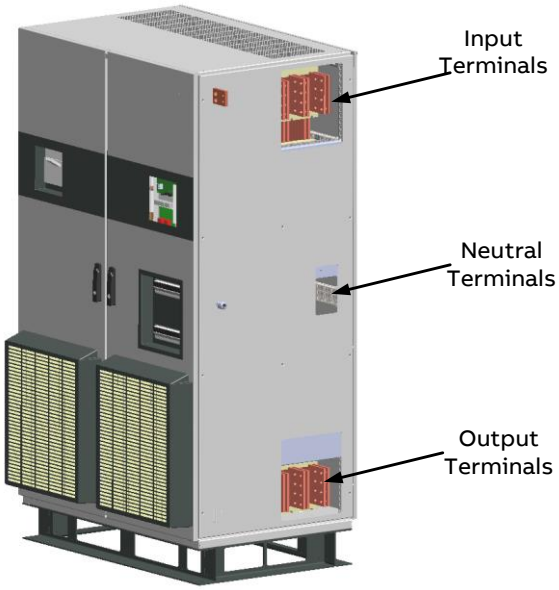


13.1.2 2200 A and 4200 A Utility Disconnect

The PCS100 UPS-I systems with a 2200 A and 4200 A Utility Disconnect have the main input and output terminals on right side of the Utility Disconnect Enclosure.

Note:

For the PCS100 UPS-I systems with included +FSx Fail-Safe Bypass option connection terminals are located on the right-side panel of the Fail-Safe Bypass Enclosure.



13.2 Control Connections

The PCS100 UPS-I includes control connections for the need of local control or monitoring of the system.
Control connection terminals are located on Auxiliary Master Module at the bottom of the Master Inverter Enclosure.

13.2.1 Digital Inputs and Outputs

Digital input and output terminals are located on Auxiliary Master Module at the bottom of the Master Inverter Enclosure and numbered as shown in Figure 13-1 and explained in **Error! Reference source not found.**.

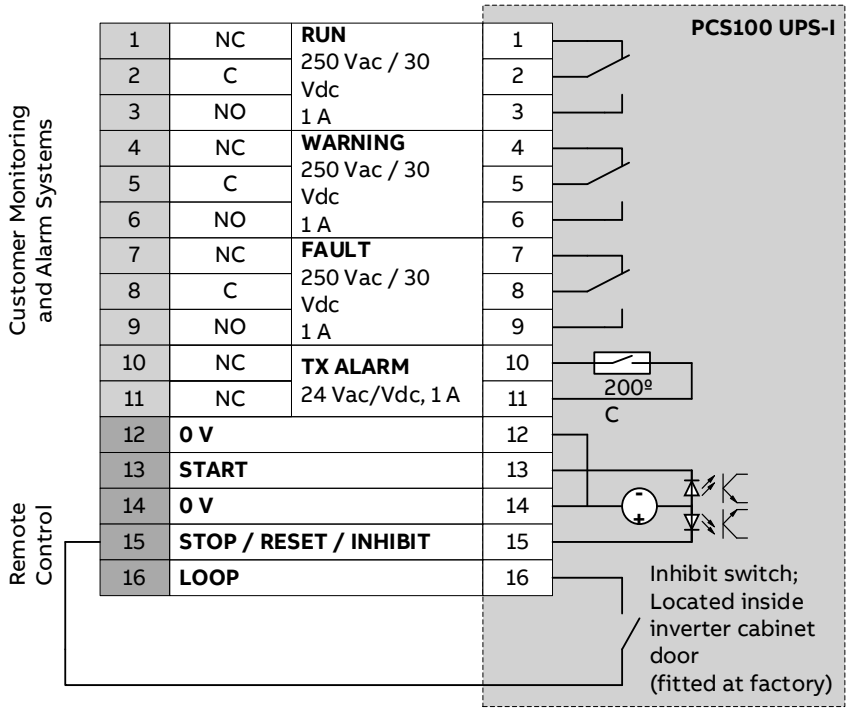


Figure 13-1: Remote Control and Monitoring Terminals

Terminal Number	Description	Name
1	Relay output / 250 Vac/30 Vdc, 1 A / NC	RUN
2	Relay output / 250 Vac/30 Vdc, 1 A / C	RUN
3	Relay output / 250 Vac/30 Vdc, 1 A / NO	RUN
4	Relay output / 250 Vac/30 Vdc, 1 A / NC	WARNING
5	Relay output / 250 Vac/30 Vdc, 1 A / C	WARNING
6	Relay output / 250 Vac/30 Vdc, 1 A / NO	WARNING
7	Relay output / 250 Vac/30 Vdc, 1 A / NC	FAULT
8	Relay output / 250 Vac/30 Vdc, 1 A / C	FAULT
9	Relay output / 250 Vac/30 Vdc, 1 A / NO	FAULT
10	Isolated thermal switch / 24 Vac/24 Vdc, 1 A / NC	Not used on PCS100 UPS-I.
11	Isolated thermal switch / 24 Vac/24 Vdc, 1 A / NC	Not used on PCS100 UPS-I.
12	Dry contact only; return wire	Remote start input – return
13	Dry contact only; start on closing edge.	Remote start Input – only used if a remote Start is required

14	Dry contact only; return wire	Remote Stop/Reset – return
15	Dry contact only; stop while open; reset on open edge.	Inhibit Switch.
16	Loop Terminal	Remote Stop/Reset input. (Looped from input 15). Inputs 13 to 15 are configured as a 3-wire start/stop which is modified as required according to parameter **541 Start Command**.

The following control connections are available for wired remote control or monitoring of the PCS100 UPS-I.

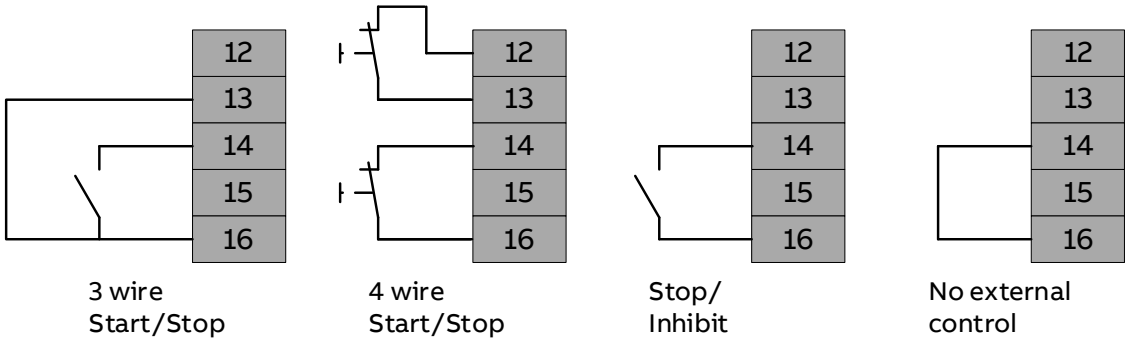


Figure 13-2: Control wiring options

Note: “No external control” link is fitted in factory by standard.

13.2.2 Emergency Power Off (EPO)

Where required Emergency Power Off (EPO) function may be implemented using a latched emergency mushroom button or control, to close a normally-open shunt trip for the supply breaker (to remove supply to the PCS100 UPS-I) and open a normally-closed Stop control circuit, as shown in figure 13-3, to prevent the PCS100 UPS-I from supplying the load from energy storage.

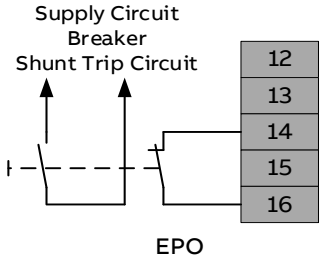


Figure 13-3: EPO wiring

13.2.3 Relay Outputs

The product status is indicated by the relay outputs mounted on the front of the Auxiliary Master Module, and may be used for external customer monitoring.

Relay	**Product status or description**
RUN	Active if ONLINE, DISCHARGING, DISCHARGE OVERLOAD, DISCHARGE T/O or STORAGE EMPTY. Not active if STATIC BYPASS or, FAULT
WARNING	Active if user WARNING condition present (temperature or overload warnings) and during power up.
FAULT	Not active if FAULT or PCS100 UPS-I is powered down.

Table 13-1: PCS100 UPS-I relay outputs

14 MAINTENANCE

The PCS100 UPS-I has been designed for ease of maintenance.

DANGER
This manual does not provide sufficient information for safe service of the PCS100 UPS-I. For such service information refer to appropriate manual.

Refer to document 2UCD074000E410 PCS100 AVC-40 Maintenance Schedule for details of recommended maintenance.
Maintenance must be carried out by suitably trained staff. The equipment must be de-energized and allowed to discharge before beginning inspections.

14.1 Maintenance Schedule

Recommended maintenance intervals and component replacements are based on specified operational and environmental conditions. ABB recommends product inspections according to list below to ensure the highest reliability and optimum performance. More detailed maintenance information can be found in the product manuals and detailed maintenance instructions.
The design lifetime of the PCS100 UPS-I product (excluding energy storage) is 15 years with operation in specified operational and environmental conditions, and maintenance performed according to the recommended schedule.
For more information consult ABB Service: **NZ-powerconditioningservice@abb.com**

	Legend
R	**R**eplacement of component
I	**I**nspection (visual inspection, correction and replacement if needed)
S	On-**S**ite work (tests, measurements, etc.)

Recommended maintenance actions	**Activity**	**Period**
Cooling		
Air ducts	**I**	**1 year**
All fans and filters	**I**	**1 year**
Connections and surroundings		
Thermal scan	**I**	**1 year**
Tightness of terminals	**I**	**5 years**
Dust, corrosion and temperature	**I**	**1 year**
Communications cables and connections	**I**	**1 year**
Aging		
AC filter capacitors	**S**	**1 year**
Spare Parts		
Spare parts	**I**	**1 year**
PCS100 inverter DC bus capacitor reforming	**S**	**3 years**
Improvements		
Software upgrades	**I**	**1 year**

Energy Storage		
Test discharge	**S**	**1 year**
Battery balance check	**S**	**6 months**
Ultracapacitor MK1 energy storage balance check	**S**	**1 year**
Ultracapacitor MK2 energy storage balance check	**S**	**5 years**
Ultracapacitor MK2 energy storage enclosure LEDs	**I**	**1 year**
Float charger LEDs	**I**	**1 year**

Note: For critical applications and applications where there is the possibility of poor environmental conditions it is recommended to shorten the above recommended periods.

Schedule of component replacement for product operation in environmental conditions up to 40° C				
		Years from start-up		
Component	**Note**	**5**	**10**	**15**
Cooling				
PCS100 Inverter module fans				**R**
Utility Disconnect fans		**R**	**R**	**R**
Ultracapacitor ES door Fans		**R**	**R**	**R**
Float Charger Fans		**R**	**R**	**R**
Aging				
CANbus cable replacement*			**R**	**R**
AC filter capacitors *			**R**	**R**
Auxiliary module power supply		**R**	**R**	**R**
SCM board	SCM rev F and earlier, systems built before 18/6/2015		**R**	**R**
SCM board battery	SCM rev G and later, systems built after 18/6/2015		**R**	**R**
PCS100 module display board			**R**	**R**

Schedule of component replacement for product operation in environmental conditions up to 30° C				
		Years from start-up		
Component	**Note**	**5**	**10**	**15**
Cooling				
PCS100 Inverter module fans				**R**
Utility Disconnect fans		**R**	**R**	**R**
Ultracapacitor ES door fans		**R**	**R**	**R**
Float charger Fans		**R**	**R**	**R**
Aging				
CANbus cable replacement*			**R**	**R**
AC filter capacitors **			**R**	**R**
Auxiliary module power supply	systems built before 31/7/2017	**R**	**R**	**R**
Auxiliary module power supply	systems built after 31/7/2017		**R**	**R**
SCM board	SCM rev F and earlier, systems built before 18/6/2015		**R**	**R**
SCM board battery	SCM rev G and later, systems built after 18/6/2015		**R**	**R**
PCS100 module display board			**R**	**R**

If for any reason there is the need to replace a module from year 8 onward, we recommend that the opportunity is taken to replace the CANbus cables at this time.

**.Valid for THDv <8%. For THDv >8% components' lifetime is likely to be reduced.
Consult ABB Service for maintenance recommendations at: **NZ-powerconditioningservice@abb.com**
To perform a balance check on the batteries, refer to ABB document 2UCD120000E416.
To perform a balance check on the Ultracapacitor modules refer to ABB document 2UCD120000E415.

14.2 Repairs

All repairs must be performed by ABB Service or an authorized service agent. When contacting ABB Service please provide the serial number of the PCS100 UPS-I and a copy of the Event Log which can be downloaded via the Remote Web Pages as described in section 12.2.4.

15 DIMENSIONS AND LAYOUTS

15.1 Dimensions and Weights

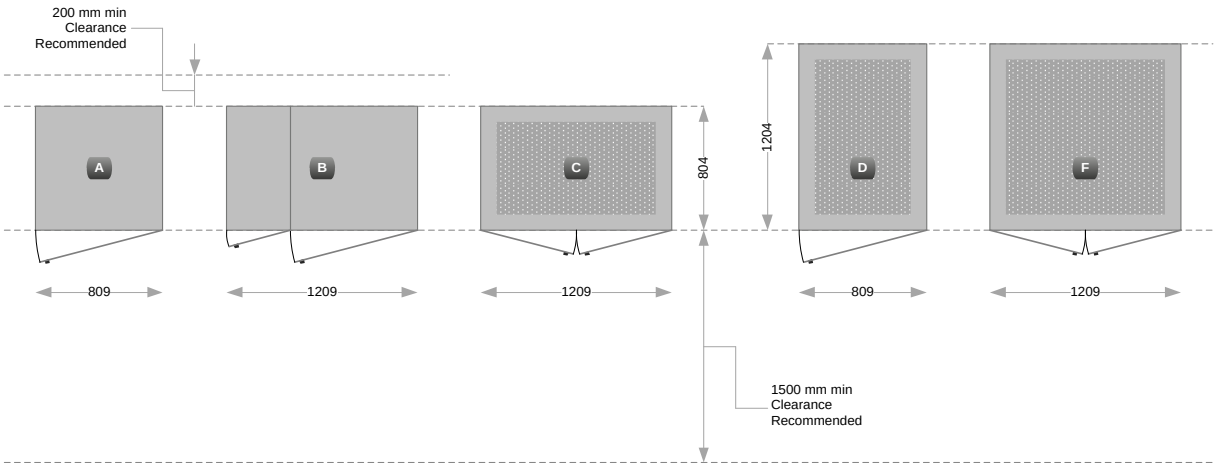
The following tables show the dimensions and weights of different types of enclosures.

Enclosure Size	Dimensions H x W x D mm	Enclosure Type		Weight kg
Shared Enclosures				
B	2154 x 1209 x 804	Inverters, Utility Disconnect and Coupling Transformer	150 kVA	785
			300 kVA	1120
		Inverters and Utility Disconnect	450 kVA	685
			600 kVA	770
			750 kVA	850
Dedicated Enclosures				
A	2154 x 809 x 804	Inverter Enclosure	Master	690
			Slave	633
		Ultracapacitor Energy Storage	One string	450
			Two strings	690
		Battery Energy Storage	One string	2043
			Empty	639
C	2154 x 1209 x 804	Utility Disconnect	2200 A	900
			4200 A	980
		Fail-Safe Bypass	2200 A	700
			4200 A	790
		Coupling Transformer		Typically, 2 kg/kVA Contact ABB for actual weights.
D	2154 x 809 x 1204	Coupling Transformer		
E	2154 x 1609 x 1204	Coupling Transformer		
F	2154 x 1209 x 1204	Coupling Transformer		

Note: Allow ±10% tolerance for all weights shown in tables above.

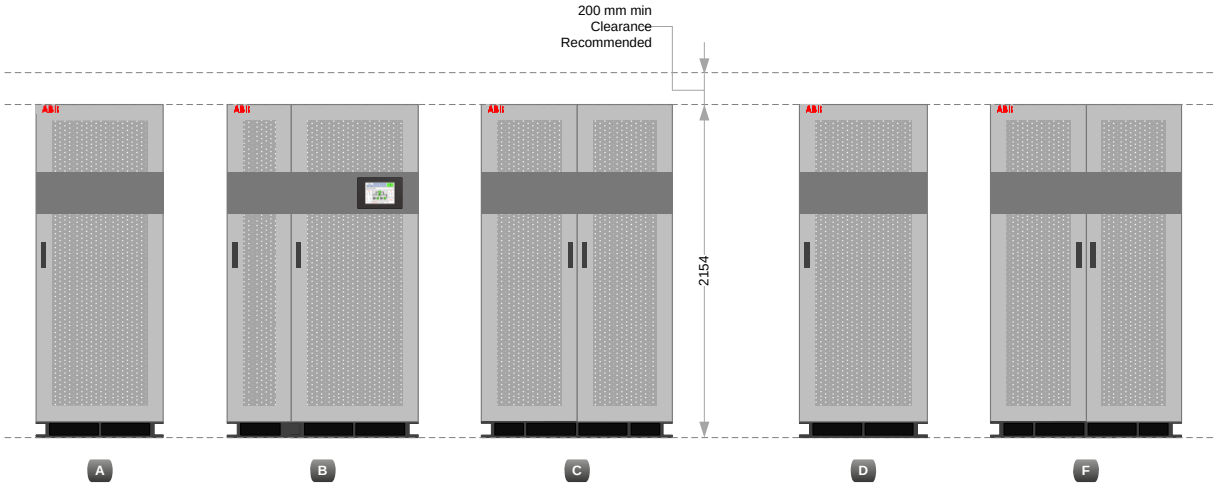
15.2 Individual Enclosures – Plan View

The following plan views show the dimensions and required clearances of the enclosures.



15.3 Individual Enclosures – Elevations

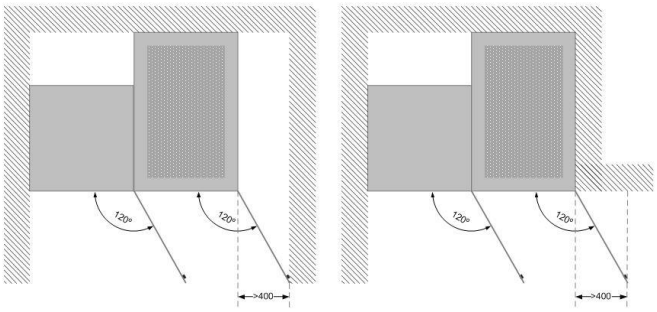
The following front elevations show the height of the enclosures and clearance required above each enclosure.



15.4 Clearances

The following clearances are required for all enclosures:

- Allow 200 mm (minimum) above
- Allow 1500 mm (recommended) clearance in front
- Allow 400 mm (recommended) clearance at the rear for testing fans, access to interconnecting wiring and installation of bus bars. 200 mm at the rear is the minimum clearance required for ventilation of enclosures placed side-by-side and 400 mm if placed back-to-back. (Exception: The Coupling Transformer and Utility Disconnect can be placed back-to-back without any clearance.)
- No side clearance required
- Side clearance to the wall at the side where the cabinet outmost hinges of minimum 400 mm is recommended to allow the doors to open sufficiently. The doors must open 120° to allow normal cabinet to access the PCS100 UPS-I module replacement.



15.5 Layout Plans

For layout plans and dimension information refer to the PCS100 UPS-I Technical Catalogue, Document number 2UCD120000E002, and installation documents / drawings.

16 PROTECTION REQUIREMENTS

16.1 Input Circuit Protection

The PCS100 UPS-I relies upon upstream protection for current overload and short circuit protection. Upstream protection should be provided by a circuit breaker.

16.2 Short Circuit Protection

The power system fault current (kA) must not exceed the fault capacity of the PCS100 UPS-I. A circuit breaker that is set to clear a short circuit failure (within the PCS100 UPS-I's withstand period) is required. For PCS100 UPS-I fault capacities and withstand periods refer to the model tables earlier in this catalogue.
Withstand period is not applicable to PCS100 UPS-I models that have a Utility Disconnect rated at 900 A or less. These PCS100 UPS-I models require current limiting 'molded case circuit breakers' (MCCBs). Current limiting MCCBs provide very fast clearing of short circuit fault currents. ABB T5 or T6 Series MCCBs or equivalents are suitable.

16.3 Input Overload Protection – Utility Disconnect

The power system circuit breaker should be set to the overload capability stated for the utility input in the specification section of this catalogue.

16.4 Arc Fault Protection

16.4.1 Arc Fault and Standards

Arc faults may happen due to unexpected occurrences and are often triggered by a service person with consequently high risk of harm from the arc. Arcs can cause lethal injury from burns, pressure and flying debris. Generally, the risk is in proportion to the energy of the fault current and time of exposure.
Safety issues in respect or arc faults are considered in the USA National Fire Protection Association NFPA 70E Standard for Electrical Safety in the Workplace. At this time there is no equivalent European standard. In the USA, NFPA 70E (and associated standards) mandates:

- Assessment of whether there are arc flash hazards (if the electrical equipment was de-energized, for example, the hazard would not be present)
- Calculation of the energy released by the arc, if present
- Determination the flash protection boundary
- Provision of appropriate personal protective equipment (PPE) for the personnel working within the flash protection boundary
- Appropriately label the equipment. These warning labels are placed on the equipment by the plant owner and not by the manufacturer. The labels shall indicate the minimum protective distance, the energy level which can be released and the required personal protective equipment (PPE).

Such study is required for all US installations.
NFPA 70E Annex D (referencing references IEEE Standard 1584-2002 - IEEE Guide for Performing Arc Flash Hazard Calculations) provides guidance on calculation of fault energies, protection boundaries, PPE and labelling.

16.4.2 Arc Fault Protection Recommendation

Electrical arcs propagate through air and equals between 30 and 50 % of the bolted short circuit current depending on arc distance. Released energy is proportional to current and time so protection must be designed to minimize both. ABB highly recommends MCCB or ACB for arc protection.

16.4.2.1 MCCBs

Fast molded case circuit breakers (MCCBs) are the highly preferable choice for protection of PCS100 UPS-I systems. Such MCCBs, such as ABB Tmax series use magnetic repulsion to successfully clear fault currents of 10 - 15 times the nominal current within about 6 ms. But note that below about 10 times the nominal current, the breakers revert to the electronic trip and are specified as taking < 40 ms to trip.

16.4.2.2 ACBs

Mechanical air circuit breakers (ACBs) do not provide any sub-cyclic current limitation in short circuits and are usually slower than MCCBs. The ABB Emax series is specified to clear in 70 ms, but EMax2 is specified to clear in only 40 ms. Other ACBs may be slower than this and protection relays may add to the time. ACBs are applied to systems from about 1500 A and above, where MCCBs are less commonly available. As with MCCBs, to minimize arc fault energy, it is critical to choose instantaneous tripping under lowest expected arc current (typically the ACB instantaneous trip level can be set to about 300% of the PCS100 UPS-I full load current rating).
To minimize arc fault energy, it is critical to choose instantaneous protection (no delay) and a tripping level less than the lowest expected arc current.

16.4.2.3 Fuses

Careful attention must be paid when choosing to use fuse for arc protection. Current limiting fuses are useful when the minimum arc current is in their current limiting range (e.g. 20 times or more). Fuses are not useful at reducing arc energy when the arc current is a low multiple of their rating (e.g. 10 times or less). When choosing fuses it is important to check that the melt time of the fuse is suitably short (e.g. 10ms) under minimum arc current conditions. Note that particularly in high current applications, fuse melt times are so long that fuses are unsuitable for providing arc fault protection.
Protection on the MV side with systems with dedicated transformer will result in increased arc fault energy for various reasons, such as MV breakers generally being slower than LV breakers.

16.5 Personal protective equipment

Due to the high levels of released energy and excessive heat it is highly recommended that the personal protective equipment is used when working around live equipment.

NFPA 70E sections (14) and (15) provide guidance on the selection of suitable personal protective equipment and ratings.
This can be summarized as:

Hazard Risk Category (HRC)	Incident Energy Minimum cal/cm2	Required FR Work Wear PPE
0	2	Non-melting Clothing
1	4	FR Shirt and FR Trousers (or FR coveralls) and PPE
2	8	FR Shirt and FR Trousers (or FR Coveralls), Cotton Underwear and PPE
3	25	FR Shirt and FR Trousers, FR Coveralls (in addition to FR Shirt and FR Trousers), Cotton Underwear d PPE
4	40	FR Shirt and FR Trousers, FR Coveralls (in addition to FR Shirt and FR Trousers), Cotton Underwear, Full Coverage Arc Flash Suit and PPE

NFPA 70E does not have a Hazard Risk Category (HRC) above 40 cal/cm2. Working in environments above 40 cal/cm2 should be avoided because of the blast hazards caused by electric arc flash. Arc flash levels above 40 cal/cm2 can be fatal and usually result in a massive pressurized blast with sound waves and projectiles. PPE is available for 100 cal/cm2 however the force from the pressurized blast can be fatal regardless of the PPE.

17 INSTALLATION REQUIREMENTS

17.1 Maintenance Bypass

ABB recommends that a maintenance bypass (not supplied with the PCS100 UPS-I) is fitted. The maintenance bypass allows maintenance to be performed on the PCS100 UPS-I without disruption to the load.
ABB requires the input and output breakers of a maintenance bypass to be lockable for an ABB service personnel to carry out any work on the PCS100 UPS-I. Please note that ABB LV breakers do not provide this as standard but as an option.

Note:
A Fail-Safe Bypass (if fitted) is not a substitute for a maintenance bypass because it does not offer isolation of the PCS100 UPS-I.

17.2 Floor Requirements

All enclosures must be installed on a horizontal fireproof surface.
Do not exceed ± 0.2° change in slope between adjacent enclosures.
Do not exceed ± 5 mm in elevation between adjacent enclosures.

Note:
Additional precaution should be taken for PCS100 UPS-I system weight, especially in battery PCS100 UPS-I systems where one energy storage enclosure weights 2043 kg.

17.3 Electromagnetic Compatibility (EMC)

The PCS100 UPS-I is designed for commercial and industrial applications. It is not suitable for connection to a low-voltage utility that is supplying residences unless additional measures are taken as per IEC 62040-2.

17.4 Location

The PCS100 UPS-I is designed for location in a restricted access location only.
The PCS100 UPS-I is designed for connection by fixed wiring.
The PCS100 UPS-I system location should be clean electrical room with controlled environment temperature and humidity according the requirements under Technical Data section.
Because of different limits of ambient temperatures of PCS100 UPS-I system and energy storage (40 ºC and 25 ºC) for cost saving on HVAC systems it is advisable to install them to different electrical rooms.

17.5 Phase Rotation

The PCS100 UPS-I does not support negative phase rotation.

17.6 Power Systems

The PCS100 UPS-I is designed for use in TN power systems. For any other type of power distribution system contact ABB for more information.

17.7 Harmonics

The PCS100 is designed to tolerate disturbances such as voltage and current harmonics in the load or supply. Excessive distortion can lead to the stressing of components leading to reduction in the lifetime of some components. For harmonics >8%THDv contact ABB for more information.

17.8 Load Imbalance

Excessive load imbalance can result in high currents in the neutral cables and connection. For load imbalance >10% contact ABB for more information.

17.9 Supply transformer

During complete electrical system design precaution should be taken for PCS100 UPS-I system supply transformer capacity, especially for battery models because of battery charging period after PCS100 UPS-I discharging mode.
As fast charging of batteries through PCS100 UPS-I Inverters can be up to 30 minutes additional load on supply transformer should be taken in consideration.

Note:
Current level during fast charging period can be set between 0% and 40% of inverter rated current, with standard setting of 10% for battery models.

18 SERVICE AND TECHNICAL SUPPORT

ABB Power Conditioning provide global service and support of installation and commissioning of PCS100 products

18.1 Comprehensive Global Services Portfolio

ABB services span the entire product ownership life cycle:

- Pre-purchase engineering
- Installation and commissioning
- Technical support
- Training
- Preventive and corrective maintenance and maintenance spare parts kits
- Retrofit and refurbishment
- Globally available, supported by regional service hubs and operating in more than 100 countries
- Spare part availability and stocking
- On-site repairs
- 24 x 365 local support line

18.2 Custom Tailored Service Contracts

- ABB services can be packaged into a custom service contract
- Tailored to the specific needs of each customer
- Contracts can be made at any stage of ABB product ownership
- Service contracts provide customers with improved cost controls, increased operational efficiency, lower capital expenditures, and extend ABB product lifetime

18.3 Life Cycle Management

ABB's life cycle management model maximizes the value of the equipment and maintenance investment by maintaining high availability, eliminating unplanned repair costs and extending the lifetime of the drive. Life cycle management includes:

- Spare parts and expertise throughout the life cycle
- Efficient product support and maintenance for improved reliability
- Functionality upgrades to the initial product

18.4 Training

- Product training includes installation, commissioning, and maintenance
- Training either at ABB Universities or at a customer site
- Training can be included in an ABB services contract

18.5 Engineering And Technical Support

ABB's engineering team provides the necessary electrical, protective and monitoring equipment, delivering a high level of energy continuity and superior power quality in a safe and cost effective system. The PCS100 is available in several capacities, depending on the scope of application.

- Pre-purchase engineering to help select and integrate ABB PCS100 products
- Customer assistance in sizing and modeling of systems

- Other life cycle engineering and technical support is available by phone, email, or on-site visits, or as agreed in an ABB services contract
- Redundant inverter design increase reliability and availability and is part of a proven family of global ABB products
- Scalable building block design

19 APPENDICES

19.1 General Disclaimer

The manufacturer shall have no obligation with respect to any product which (i) has been improperly repaired or altered; (ii) has been subjected to misuse, negligence or accident; (iii) has been used in a manner contrary to the manufacturer's instructions; (iv) has failed as a result of ordinary wear and tear, or (v) has not been serviced and maintained as per the manufacturers maintenance schedule and associated procedures.

19.2 Recycling Information

The main parts of the product can be recycled to preserve natural resources and energy.
Product parts and materials should be dismantled and separated.
Generally all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, cardboard and other packaging material can be used in energy recovery. Printed circuit boards and DC capacitors need selective treatment according to IEC 62635 guidelines. To aid recycling, plastic parts are marked with an appropriate identification code.
Contact your local ABB distributor for further information on environmental aspects and recycling instructions for professional recyclers. End of life treatment must follow international and local regulations.

19.3 Waste Electrical and Electronic Equipment Information (WEEE)

The crossed-out wheeled bin symbol on the product(s) and / or accompanying documents means that used electrical and electronic equipment (WEEE) should not be mixed with general household waste.
If you wish to discard electrical and electronic equipment (EEE), please contact your dealer or supplier for further information.
Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling.

19.4 Glossary

Term	**Description**
CB	Circuit Breaker
CESE	Ultra**c**apacitor **E**nergy **S**torage **E**nclosure
CGI	Common Gateway Interface. CGI software is used when passing data between the Vcan serial communications bus and the remote web pages.
CT	Current Transformer (sometimes means Coupling Transformer).
DSPE	Digital signal processing engine. Control processor board. Fits on top of the MSIB and VSIB
GDM	Graphic Display Module. The main HMI (Human Machine Interface) for the PCS100 products
GDMIB	Graphics Display Module Interface Board. A small circuit board inside the GDM. Its main function is an interface between Vcan and the GDM.
MSIB	Master Stack Interface Board (located in the master module)
NC	Normally closed (Relay)
NO	Normally open (Relay)
PCB	Printed Circuit board
PCS100	A generic range of ABB LV power converter products.
PTC	Positive Temperature Coefficient temperature sensor.

SCM	System Configuration Module. A small circuit board located inside the master module. When the PCS100 product powers up the SCM checks the SW revisions and the hardware configuration (i.e., the number of inverter and rectifier modules).
VCAN	The name of the high-speed serial communications bus protocol used by the different modules in the PCS100 products to communicate to each other. These modules are the Master Module, Inverter Module, Rectifier Module, SCM and GDM.
Vcanserver	The name of the driver software for the Vcan bus
VSIB	Slave Stack Interface Board (located in a inverter or rectifier module)
VT	Voltage Transformer or potential transformers (PT) for metering and protection in high/medium-voltage circuits

Table 19-1: Glossary

19.5 Open-Source Software

This product incorporates software from open source communities. For more information refer to the document 2UCD200000E041 PCS100 Open Source Software Information.

19.6 Detailed Single-Line Diagram

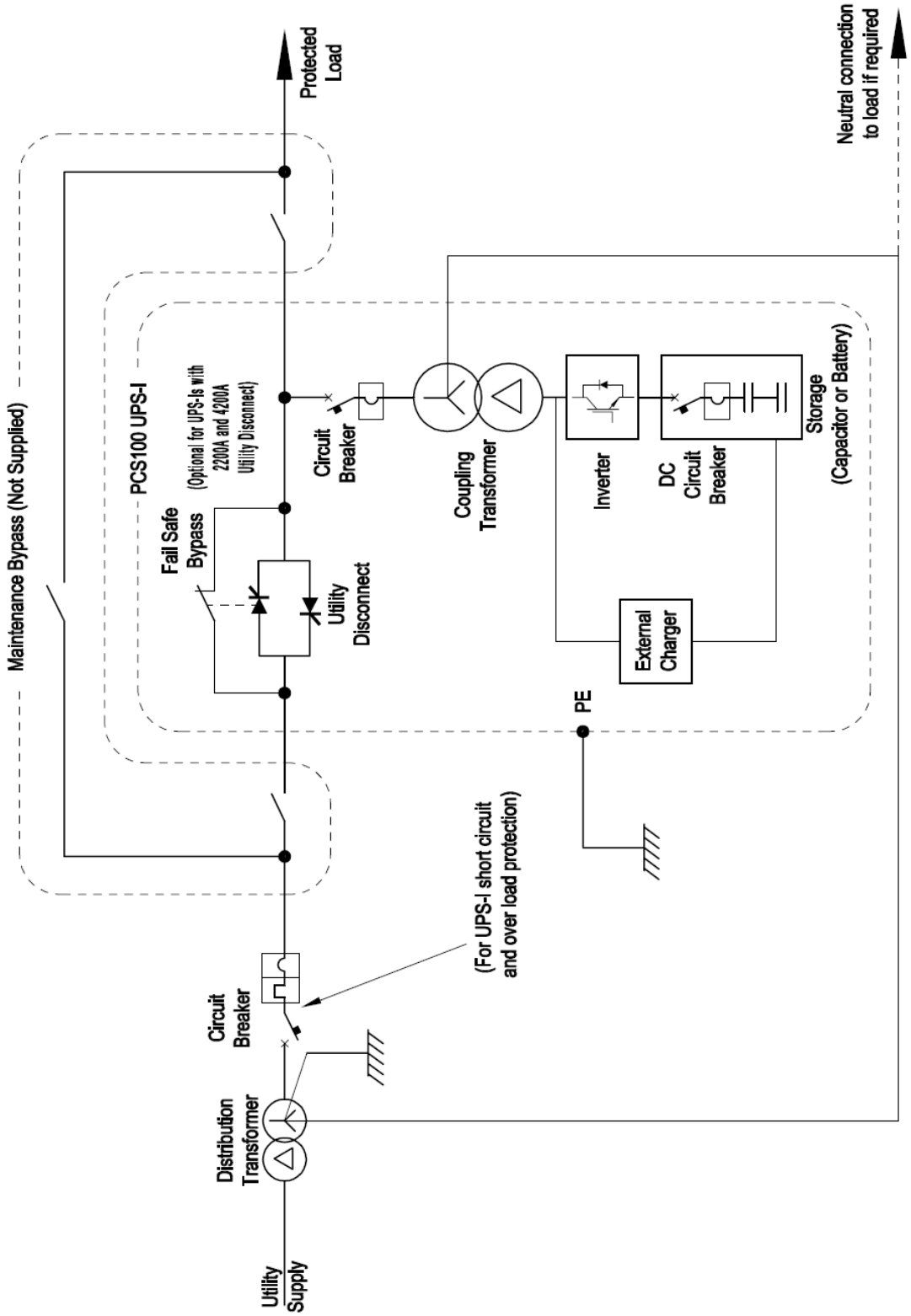


Figure 19-1: PCS100 UPS-I Single line diagram

19.7 Torque settings and Bolt order

Following table shows torque settings recommended for the power cable connections.

Tightening Torque for Standard Bolts and Nuts		
Diameter (mm)	**Pitch (mm)**	**Torque Nm (lb ft) Use only high tensile bolts**
M5	0.8	4.5 (3.6)
M6 (battery terminals)	1.0	4.0 (3.2) *
M6	1.0	7.2 (5.3)
M8	1.0	16 (11.8)
M10	1.25	28 (20.7)
M12	1.25	45 (33.2)

Table 19-2: Tightening torques

* Stainless steel screws in to copper battery terminal. Must use insulated tool to avoid dangerous accidental flashover.

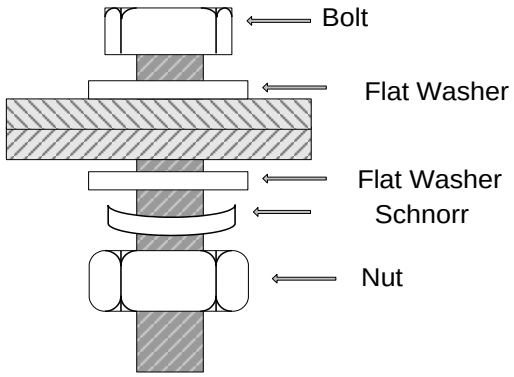


Figure 19-2: Bolt order

20APPENDICES

Document number	Name
2UCD120000E002	PCS100 UPS-I Technical Catalogue
2UCD120000E004	PCS100 UPS-I Installation Checklist (large models)
2UCD120000E013	PCS100 UPS-I Customer Batteries AN
2UCD120000E014	PCS100 UPS-I Understanding and Adjusting the PCS100 UPS-I Voltage Event Detector
2UCD120000E015	Bypass Trigger for PCS100 UPS-I Maintenance Bypass
2UCD120000E017	PCS100 UPS-I Application to other than center referenced solid earthed power systems
2UCD120000E018	PCS100 UPS-I and battery derating for 30 -300s AN
2UCD120000E019	PCS100 UPS-I product efficiency AN
2UCD120000E023	PCS100 UPS-I Transfer Performance
2UCD200000E041	PCS100 Open-Source Software Information.
2UCD120000E406	PCS100 UPS-I Spares List – PCS100 UPS-I (2200 A & 4200 A UD)
2UCD120000E407	PCS100 UPS-I Spares List – Battery Energy Storage
2UCD120000E408	PCS100 UPS-I Spares List – Ultra Capacitor Energy Storage
2UCD120000E409	PCS100 UPS-I Service Guide - Large Models
2UCD200000E410	PCS100 Maintenance Schedule
2UCD120000E411	PCS100 UPS-I Service Guide (900 A)
2UCD120000E413	PCS100 UPS-I Commissioning Checklist (large models)
2UCD120000E414	Service Instruction – Ultra Cap Replacement
2UCD120000E415	Service Instruction - Ultra Cap Balance Test
2UCD120000E416	PCS100 UPS-I Service Instruction - Battery Balance Test
2UCD120000E420	PCS100 UPS-I Spares List – PCS100 UPS-I (900 A)
2UCD120000E421	PCS100 UPS-I Installation Checklist (small models)
2UCD120000E422	PCS100 UPS-I Commissioning Checklist (small models)
2UCD120000E425	PCS100 UPS-I 6 Monthly Maintenance Checklist
2UCD200000E001	How to View the GDM Web Pages

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