TEST DEVICES

Module Test Simulator

The function of the simulator is to test the static and dynamic functions of the AC and DC control modules. The process confirms that the modules will perform flawlessly as required for during drilling operation.





Power Limit Controller Test Fixture

The power limit system will monitor the engine loading KW and the generator loading KVA of each engine/generator set. If any of these parameters reach their limits, the power limit circuit will reduce the power being delivered to the loads so that the load on each generator is held at its limits. The percent power limit is indicated by a meter on the test fixture. The power limit controller test fixture can accurately measure the limiting value of the power limit controller.



HHCT Electric Control & Drive System HHCT Electric Control & Drive System HHCT Electric Control & Drive System



GLOBAL SOLUTIONS DESIGNING, MANUFACTURING AND PACKA



TSC Offshore, 7611 Railhead Lane, Houston, Texas 77086, USA Tel: +1 832 456 3900 Fax: +1 832 456 3901 Email: sales@tscoffshore.com Visit our Website at www.tscoffshore.com



TSC GROUP



DESIGNING, MANUFACTURING AND PACKAGING FOR THE OFFSHORE INDUSTRY

Beyond Integration Seamless Solutions™

ABOUT TSC HHCT

TSC HHCT, a business unit and brand under TSC GROUP, is a complete of control & drive solution, VFD and control cabin solution provider of oil and gas industry ever since the company was founded in 2001. Advanced technology for R&D, manufacture, production, marketing and service of onshore and offshore rig control system and package system has pushed through and supported more achievements within the industry to date.

TSC HHCT products are field proven, efficient and reliable:

- Being capable of supporting the major body of foreign drill rig in China. \checkmark
- Highly respected by Siemens China Ltd as automation and drive group senior system integrator partner.
- \checkmark High end technology enterprise award granted by government.
- ISO 9001 certificate in 2003. \checkmark
- DNV certificate in 2009 \checkmark
- First grade China Oil and Gas provider Network Certificate in 2007
- \checkmark In-time service and spare parts provision. Flawless problem execution.



Automatic Drilling System

The ADS (automatic drilling system) utilizes the control capabilities of a PLC with an integrated HMI screen. The result is a powerful system which is both safe and easily operated.

ADS controls the drilling tool speed and location based on input from an encoder coupled to the drawworks. Input from a dead line transducer is used to control and monitor speed of motor or weight on bit. Input from a mud pressure transducer can be used to control mud motor pressure delta as a drilling parameter.

The ADS control functions include: weight on bit, rate of drilling and mud motor pressure delta. The system includes dual limits for alarm and shut down which operate independently of the function control set points.

Travelling Block Positioning System

The PLC based RWCS uses input from the drawworks limit switches backed by proximeters installed in the mast to detect the position of the travelling block and provides real time feedback and position from the travelling block compared to limits set via the HMI to ensure the travelling block does not enter unsafe areas. The system includes the capability to limit travelling block speed as well as position to further ensure safe operation. Automatic braking and manual bypass are also available.





TSC Offshore, 7611 Railhead Lane, Houston, Texas 77086, USA Tel: +1 832 456 3900 Fax: +1 832 456 3901 Email: sales@tscoffshore.com Visit our Website at www.tscoffshore.com





AC Drive

TSC designs and packages complete AC variable frequency drive systems for the drilling industry. Through rectification all AC drives convert AC to DC and then through various switching techniques invert the DC into variable voltage, variable frequency output. The AC control system utilizes advanced digital vector technology which greatly improves the speed adjusting specification of AC motors and system power factor.

AC Drive Features

- · 12-pulse and regenerative configurations
- · Active front ends
- Harmonic filtering
- Fully digital control
- Minimum 95% efficiency
- Touch and display screens for display of drilling parameters





The complete power and control of the SCR or AC drive system is designed, built and integrated by TSC engineers and technicians specifically for your application. The combination of our control system and drillers cabin virtually eliminate problems with multi-source product integration.

VALUE & CAPABILITIES

TSC HHCT has developed a series of control and drive system, high integrated control driller's cabin, leg jacking control systems, electrical mains system and power compensation, harmonic suppression system for different drilling rigs on- and offshore.

- based on a redundancy design.
- Stable Operation---satisfying different applications, such as jack-ups, semi-submersibles and drill ships by offering 600V/480V/220V power distribution management, power drive and control. Superior Quality---utilizing high-end qualified AC, DC Module from USA. Fine Technology---the latest technology and craftmanship
 - High performance & high cost effectiveness
 - Round-the-clock and round-the-world services

APPLICATION SCENARIO

- TSC HHCT meets all your requirements from onshore to offshore. \checkmark
- MOBILE OFFSHORE DRILLING UNITS 2006 based design

FOOTPRINT

 \checkmark

TSC HHCT has offered 260 sets of SCR and VFD totally since 2001 with the footprints on Middle East, North and South America, West Asia, Southeast Asia and Africa, etc.

Offshore Products

- control, marine electrical system, ESD and integrated driller's cabin.



Reliable Products---including digital GEN set control, power source management, flexible disposed MCC, dynamic VFD drive control, drilling operation PLC control and industrial network communication system

TSC HHCT has signed a contract to supply some complete sets of electric control system for Super M2 Jack up rigs, including diesel generator (GEN) set control, power source management, drilling VFD drive

TSC HHCT has successfully delivered to sets of VFD systems with ABS certificate for jack up rigs.

TSC HHCT won a contract with COSL to supply control solution and electrical engineers training services.



Offshore Drilling Platform Power Control System

Offshore drilling platform power control package with 600/480/200V power distribution and management, drive and control on the jack-ups or semi-submersible. This constant system can satisfy the demands of the offshore drilling vessel.





The design is based on the ABS MOBILE OFFSHORE DRILLING UNIT 2006 and conforms to the demands of offshore drilling. As a component of offshore drilling platform, our power package will perform excellently. It includes digital diesel generator set control system, power management system, MCC, VFD drive system, logic control system of management program, and communication system of industrial network. As an equipment provider, we will provide a perfect after sale services. It is believed that we will do it better.

Digital Diesel Generator Set Control System

The control module is a full digital controller based on a micro processor. It includes generator control, synchronization, load control, sequential control on generator set, electric parameter detection, protection, communication and display function. It is a foundation of power management system and makes the control module take the local and remote operational orders to control the generators; it also receives the relevant data from power management system according to the demands from the programmable controller.

Control Module Functions

- Locally/remotely start or stop the generator set
- Locally/remotely operate the generator to get synchronized, online/offline
- Generator soft load and unload
- Auto load balance
- Auto reactive power balance
- · Generator protection, such as over voltage, under voltage, over frequency, under frequency, over load and reverse power

Composition

It is composed of incoming / outgoing cabinets, TCR cabinet and FC cabinet and comprehensive cabinet.

- power.
- at around about 1.
- d. PLC control unit and PLC monitor unit are equipped in the comprehensive cabinets.

PLC control unit is highlighted by that 3-phased reactor connected with 3-phased capacitor via silicon controller rectifier bridge to keep the power factor at 1. PLC technology is adopted and it can be operated by man or without man. The whole device satisfies the power factor varibles correction and harmonic suppression. All in all, the system comes up to the national standards and it is economic easy to operate with stable to anti-inference.





TSC Offshore, 7611 Railhead Lane, Houston, Texas 77086, USA Tel: +1 832 456 3900 Fax: +1 832 456 3901 Email: sales@tscoffshore.com Visit our Website at www.tscoffshore.com

a. Electrical capacity detect unit and power incoming / outgoing cables are installed in the incoming / outgoing cabinets. The unit will detect the electrical power of AMP, V, KW,KVAR from outsource

b. In TCR cabinet, there is a silicon controller rectifier bridge unit in which PFC module (power factor correct module) is a core. The inductive loads are controlled by the PFC and added with that of drilling equipment, the total sum will be distributed together with the capacitive load to keep the power factor

c. 3 capacitors with the same capacity and 3-phased reactor in FC cabinet, The number of FC cabinets are needed is dependent on the drilling condition. The total reactive power compensation capacity is decided by the maximum. odd harmonic. FC cabinet quantity comes from the capacity of each capacitor divided by the reactive total compensation which is decided by the odd harmonics.



Rig Electrical Mains System

Rig electrical mains system could transform industrial mains electricity energy into power source applied in conventional rigs, so the rig works more efficiently and produce less s energy waste and pollution. In addition, the system allows interchange between diesel and electricity systems as well as old rig update. The whole system is composed of rig grid power supply system, rig dynamic power factor compensation and harmonic suppression device.

Power Supply System

Composition

The system consists of high-pressured incoming cabinet, measuring cabinet, transformer and low-pressured outgoing cabinet.

- a. High-pressured part consists of high pressure measuring cabinet and outgoing cabinet with 10KVor 35KV and etc
- b. Featured by a load pressure adjustment, 4000kVA 10kV/0.6Kv or 35KV/0.6KV transformer transform the high pressure into 600V used usually in rig site. Thus this may effectively avoid a voltage fluctuation resulted from load wave and working condition transfer.
- c. Low-pressured part consists of low pressure outgoing cabinet, DC screen, power distribution cabinet and lighting transformer.

Rig Varible Power Factor Compensation and Harmonic Suppression Device

Generally, the diesel generator set is a power for a land used electric drive rig in which the silicon controller rectifier is the power provided for DC system. This system has a lower power factor, and the electricity is not fully used, some it is a waste in generator and fuel oil. Meantime, SCR system makes AC electricity mains a lot of harmonics, mainly 5th, 7th and 11th harmonic.

Power factor rectification device includes several capacitors, silicon controller rectifiers and a reactor. When the electricity mains is a negative data, the silicon controller rectifier will be off; when the electricity mains is a positive data, the silicon controller rectifier will be on. Like this, the power factor will be kept always around about .

Controlled by PLC, capacitor works itself, its adjustment is smooth, no firing and no sparkles.

Based on a total capacity of reactive compensation, the harmonic suppression system will distribute the reactive compensation capacity and consists of a suppression loop circuit with an inductor.

Power Management System

Based on digital diesel generator set control system, PLC technology, industrial network technology and HMI, the power management system will optimize the control on generator and keep a close watch on the parameterized data. In this system, all the remote operation and display are located on the instructive station of a touch screen in the central control cubicle, but the local operation and display on the generator set control cubicle or driller's console.

Functions of Power Management System

- According to the states of loads automatic start or stop the generator set
- · Parameter set of the generator load
- · Sequential control of generator set auto start or stop
- · Alarm and emergent stop
- · Single display the states of generator set and public main bus
- · Display the data of generator set and main bus
- · Operation authority management

Flexible Disposal MCC

MCC provides the MAIN MCC, VENTILATION MCC, DRILLING MCC, DRILLFOOR MCC and EMERGENCY MCC with different voltage such as 480V and 220V. MCC has many control methods such as HOA/3WRC/S-S and so on. Besides, it can decrease the voltage of a motor for big power to minimize the attack suffered for the power supply.

VFD Drive System

VFD drive offers the drawworks, top drive/rotary table and other drilling devices a smooth and steady power. VFD drive system is better featured. For example, it makes most use of electricity and has a simple construction and a smooth speed and torque control. Additionally, it keeps noise low and takes a small installation size, reliability and longevity

Strong Points Showed by the Frequency Converter

- the dynamic brake to the DC main bus for the use of other devices. Thus, it saves a lot of energy.
- It has a torque limit and over load protection.



TSC Offshore, 7611 Railhead Lane, Houston, Texas 77086, USA Tel: +1 832 456 3900 Fax: +1 832 456 3901 Email: sales@tscoffshore.com Visit our Website at www.tscoffshore.com





· Compared to the series excitation motor, the VFD system provides a better speed adjust. The effect of motor speed suffered from the loam becomes smaller. Vector running will be not fluctuated with the load. In addition to that, the encoder will output about 80% rated torque at the zero speed to have a suspension stop. · The power factor of VFD speed adjust system reaches at 0,99 and feedbacks the energy accumulated at



- · Via the special interface, the frequency converter is connected to the computer, so that the well site and the drilling parameters will be monitored at time.
- No commutator in the frequency motor, so the repair and maintenance cost will be low.

Logic Control System of Drilling Operational Program

Since the drilling operation is controlled by PLC, accuracy and reliability are improved.

Industrial Network Communication System

The most advanced industrial communication network, industrial Ethernet and PROFIBUS network, change the signals into the full digital transfer to make a more accurate and reliable signal transfer. And a collar design is used, so that a perfect communication is ensured.

Driller's Cabin on the Digital Drilling Vessel

The driller's cabin controls most of the drilling equipments. In the cabin, the driller's console is an integrated digital control and monitor system. This console includes the operation of top drive, rotary table, drawworks, power management, mud monitor system, mud pump control and auxiliary mechanical operation. In a drilling process, this console provides the drillers with a central control and monitor method. At the same time, via the commutator connected to the Ethernet, the console will communicate with the equipment connected with PLC to control all the equipment on the well site.



DC Drive

The global success of TSC modules is a result of the reduction of all vital electronics for the AC and DC functions of the system to a single circuit board. All modules of each type are interchangeable and identical for replacement in minutes. The modules are hard-wired to eliminate loose connections caused by vibration. Each module is subject to rigorous testing to eliminate any inferior components. Modules are calibrated at the factory and require no adjustments in the field. Service and troubleshooting of the system is minimized.

AC Control Module

The AC module consists of the electronics for automatic control of the engine generator set:

- · Electronic engine governor
- voltage protection

DC Control Module

converter:

- Automatic load sharing system for the drawworks, rotary table and mud pump motors · SCR firing circuits with 'hard firing pulse' output

- Gate suppression at approximately 150% of the highest single motor current limit · All controls are designed to be 'fool-proof'
- · Individual control of current limits for all drilling functions
- · Zero throttle interlock

SCR or AC Power Control House

motor control center, drawworks dynamic brake control, transformers, and AC cooling units. drawbar at each end of the house are provided for transportation on a trailer.

- · Factory wired and thoroughly tested as a complete system prior to shipment · Weatherproof AC and DC connectors are located on one end to the house.



TSC Offshore, 7611 Railhead Lane, Houston, Texas 77086, USA Tel: +1 832 456 3900 Fax: +1 832 456 3901 Email: sales@tscoffshore.com Visit our Website at www.tscoffshore.com

- · Electronic generator voltage regulator
- Automatic load sharing circuit for parallel operation

· Reverse power, under frequency, over-frequency, pulse loss and over-

The DC module consists of the electronics for automatic control of the SCR

- The power control house provides the features of economic operation maintenance, compactness, and portability. The house contains the SCR or AC drives, generater control cubicles and other associated equipment to include
- The self-supporting power control house is mounted on a three or four runner oilfield skid. Lifting eyes or a



DC Drive System Generator Controls

Multi-Function Instrument/Meters

- Accurately Control Engine speed and generator voltage
- · Ground fault detection system
- Synchronizing panel
- Power limit circuit
- Analog or digital controls
- · Multi-protection of engine generators

SCR Controls

- Rectifier Bridge rated at 2000 amps continuous at 750 volts DC
- Surge suppression system
- Multiple assignment of the SCR rectifier bridges through the use of contactors
- Digital or analog controls
- Lockout switches for each motor
- PLC

Driller's Console

The console is located on the drill floor and is the main control and monitoring device for each drive function fo the drilling rig. It contains the control switches for the SCR assignments, throttles for each motor, rotary table torque limit control, and drawworks or rotary table reversing, selection switches, instruments, pushbuttons...

- Explosion-proof pressurization system with alarms
- Drip-proof stainless steel construction
- Foot throttle for control of the drawworks during hoisting
- PLC-based control equipped with cable bypass for spare use.
- Indicator lamps
- · Touch screen and display screen

SOLID CONTROL EQUIPMENT Electric Drive and Control System





The functions on the above diagram are composed of the following hardwares and softwares:

Hardware

- · Disc instrument, disc brake, Eton brake and other auxiliary mechanical units

System Functions

Based on the WINDOWS XP PROFESSIONAL Operation system, WinCC software platform, we devoloped power managenent system, drilling control monitor system, DW control system, DT/RT control system, MP control system, auxiliary mechnical control system, travelling block ant-collision system, CCTV monitor system, data management system, alarm system, fault diagonal system and integrated digital control system designed for driller's console.

Power Management

- 3 modes for starting and stopping the generator set, that manual, auto and waiting
- Parameters of generator (V, I, f, kW, kWh, COSΦ) displayed on the screen
- Engine generator protection and alarm
- Record of current and previous data and tendency





 Switches, buttons, handle, touch screen and digital key board are mounted on the console at sides of the chair Two industrial control computers and two display touch screens are mounted on the driller's console.



Drawworks Operation

- Drum speed and torque control
- Setting of WOB and ROP under a mode of auto bit feed •
- Setting and adjusting of stop (brake) point of travelling block •
- Accurate management to the static and dynamic stopping point
- Monitoring, management and alarm under a condition of brake •
- Position of drilling platform/crown block and travelling block (display and data) •
- Scale and calibration instrument •
- Hook load •
- · Record of current and previous data and tendency

Top Drive And Rotary Table Operation:

- Hydraulic and electrical control
- · Manually and automatically buckled and shackled by means of torque increaser and motor
- Setting and dynamic adjust of motor and torque boost •
- Oblique lifting ear, BOP, monitoring and controlling brake



SYSTEM SUMMARY

Since 2001, TSC has been designing and building SCR drives utilizing proven technology for oil and gas applications. Each power system is manufactured to meet customer specifications and at the same time complies with the stringent requirements of the drilling industry - reliability, ease of maintenance, and simplicity.

TSC maintains a world-wide network of field service personnel and technicians that can support your operation on a 24 hour basis.





TSC Offshore, 7611 Railhead Lane, Houston, Texas 77086, USA Tel: +1 832 456 3900 Fax: +1 832 456 3901 Email: sales@tscoffshore.com Visit our Website at www.tscoffshore.com



Speed Accuracy Adjust System \checkmark

There are two speed control in the system, at the same time, a speed accuracy adjust system is showed on the touch screen. When some external objects causes an inconsistent leg height during the platform is working, the speed referenc is available to adjust on the screen, so that actual height of each leg will be the same.

Jacking Anti-Saver System \checkmark

A height detecting encoder is mounted in the system, when the leg travels to a preset alarm point, a visual and audibel alarm will be made. When it travels to a slowing point, the leg will automatically slow down. And when it travels to an emergent point, the system will send out braking signals to activate the braking unit and prevent the leg from moving to a limit point.

Platform Inclination Correcting Sysem

After a limit inclination angle is preset, when the platform inclination angle comes to a limit inclination angle, the system will automatically calcuate and ajust the correspondent leg speed to correct the inclination angle, so that, the system comes to a safety area.

Fault Diagnosis System \checkmark

The fault diagosis system list is designed. When there is something wrong in sysem, the list will help the users to understand the fault so as to solve the problems as soon as possible.

RPD Protection Function (Optional)

System will send audible and visual alarm to operator for leg rectification if one of RPD value of leg exceeds rated alarm limits.

Leg movement would be stopped if the RPD value exceeds the failure limits.

Data Record Function (Optional)

Seamless link between control platform and Siemens WICC configuration software; Or according to users' demand, parameters configuration and hard-disc data recording are available.

- Torque elevator boost pressure
- Rotary table forward and reverse rotating
- Rotary table speed and torque control •
- Function record and tendency

Mud Pump Control

- · Pressure adjust to stabilize the well control
- · Calibrating and resetting the mud storage and its data on the screen
- · Real-time and historical data logging and trending

Mud Monitoring

- · Display and alarm setting of the fluid level in mud tank
- Display and alarm of increase and decrease of mud •
- Detect and alarm the harmful gas •
- Stand pipe pressure
- Casing pressure •
- Scale and calibration on the instrument screen in the well site •
- Calculate the mud density and display
- Real-time and historical data logging and trending

Auxiliary Mechanical Operation

- Flexible plate
- Iron roughneck control
- Power slips for rotary control
- Mud preventer
- Hydraulic catwork
- Drawworks shift gears
- Eton brake
- Setting and adjusting of brake moment •
- Disk brake control

CCTV

- Camera direction control
- Camera focalization •
- Composition and embedding





Structural Trait of Driller's Console

The driller's cabin structure and design meet the requirements by the machine, the power, the liquid and the air. It is to be explosion-proof, corrupt-proof, damp-proof, flame-proof and sound insulation.

Control and display systems in the cabin are convenient to operate and the arrangement and design inside the cabin is featured by a simple structure and intelligent management.

The driller's cabin is constructed by a steel frame, which has a very good sealing property. So that 50-250Pa pressure are maintained.

An explosion-proof air-conditioner (cool and hot temperature available) is mounted in the cabin. Additionally, there are adequate lights and emergent lights.

All windows are made of reinforced glass. So it is concluded that the drillers work in a comfortable and safe cabin.

VFD DRIVEN LEG JACKING CONTROL SYSTEM



General Introducion of System

The system is composed of VFD driver (VFD), Motor Control Center (MCC), leg length detecing system, central control console (CCC) and platform inclinometer. Via communication between the man and the machine, the system will be monitored and controlled.

Composition of System

It consists of port leg, forward leg, starboard leg drive and control system, control control console and braking resistor.

Operation and Control

- a) Two Modes
- 1. Remote integrated control
- 2. Local control

- b) Two Speeds
 - 1. Leg normal speed 1.50 feet/m
 - 2. Leg normal speed 1.65 feet/m
- c) Local Control
 - 1. Select the local control
 - 2. Work on the local control in the local control box Speed of each leg may be ajusted as to the running states.

Monioring System

It is equipped with a touch screen in which there are two modes, namely, monitoring screen and controling screen. Each leg has these two screens.

Monitoring Screen

Functions listed as following:

- Leg running states, speed, rate, current, voltage, power
- Leg running length
- · Motor running states, current, overload and fault information
- Motor brake running states, switch position and fault information
- Leg dynamic running, fault information
- Motor current alarm setting value

Control Screen

Functions listed as following:

- Total load, average load, maximum load, minimum load on each leg conner
- Display the running length and its correction setting
- Speed adjust system
- · Upper limit and lower limit alarm piont and their alarm points
- when the system stops
- Torque distribution setting of leg single motor
- · Load monitor of leg single motor



TSC Offshore, 7611 Railhead Lane, Houston, Texas 77086, USA Tel: +1 832 456 3900 Fax: +1 832 456 3901 Email: sales@tscoffshore.com Visit our Website at www.tscoffshore.com

HHCT Electric Control & Drive System

When the first mode is selected, the operation will only be finished at the control console.

Electronic inclinometer monitoring system and its inclination parameters and the inclination parameters

