# SIRIUS™ AC/DC Source

## Introduction

The ***SIRIUS***™ **Solid State AC/DC Voltage Source** is a highly advanced programmable electronic voltage source designed to provide all of the required power input characteristics needed to test any type of medium power electronic equipment. The unique and flexible output design of ***SIRIUS***™ allows users or engineers to easily configuring its modules for any combination of power and voltage required. Each of the ***SIRIUS***™ power modules may be programmed to be AC or DC power sources, and may operate independently or in parallel to support a variety of applications. No longer is it necessary to purchase oversized sources or multiple sources to support a mix of source application needs. The ***SIRIUS***™ three-channel source may be equipped with any desired quantity of power modules on each channel, and the three channels may be software defined to operate independently or in parallel, and in any combination of operating modes.

## Control and Operation

### Remote operation IEEE 488.2 programming.

*An **IEEE 488.2** interface utilizing a **SCPI** style command structure.*

The ***SIRIUS***™ Oscillator Control Module provides a process controlled communications interface operating to ***IEEE 488.2*** standards. The logical plan language text based interface allows both simplicity and flexibility in programming. Formulated around the requirements of the ***SCPI*** command standard, the control statement structure is powerful in features yet simple in structure.

### DC, Single Phase AC, multi-Phase AC outputs

*Low Impendence "H-Bridge" output with 256 possible 180 point Arbitrary wave shapes.*

The unique "H-Bridge" output architecture allows the lowest possible source impendence with easy configuration for independent or parallel AC or DC operation. Each of the ***SIRIUS***™ modules may be programmed to operate as a dual mode DC source with full voltage and current programming. They may also be operated as an Arbitrary Waveform AC source using the four internally configured 1800-point waveforms, or up to 156 user provided downloaded Arbitrary AC Wave Shapes. All wave shapes may be described in from 4 to 1800 points for accurate low distortion waveforms. Channels may be totally independent or internally synchronized for parallel or multi-channel source architectures.

#### Single range 0 – 400VDC and 0 – 282VAC @ up to 4kHz.

*0-400VDC*
*0-282VAC*
*0-833Hz @ 1800 Points*
*0-4166Hz @ 360 Points*

The vertical Channel program value may be set with either Peak or RMS values. The voltage is programmed over the range of 0-400VPeak, or 0-282VRMS. The frequency may be programmed at from 0 to 4166Hz for a 360 Point user defined waveform. Channels may be programmed separately or together as the application so dictates.

### Independent or Parallel Operation

*Fully programmable Independent/Parallel AC/DC Source.*

Any or all of the Channels may be operated in AC or DC Parallel to increase the power and current ability of the source requirement. They may also operate in any combination of modes. In one application, the three channels may be a parallel DC or AC source. In another, one channel may be a DC Source while the other two operate as a Line-Line AC Source. And in yet another, the three channels may be an unbalanced, phase shifted Three Phase AC Source. Moreover, the ***SIRIUS***™ could be three asynchronous AC Sources operating at different frequencies and voltages.

# Protection Circuitry

### Power Factor Correct

To provide the most efficient and reliable module operation, each ***SIRIUS***™ module is equipped with Power Factor Corrected AC inputs. This reduces ATE line disturbances during test operations, and decreases the power losses of the ***SIRIUS***™ modules.

### Over Power, Over Current and Over Temperature protection

Each ***SIRIUS***™ module detects, protects and reports hazard conditions incurred during test applications. These high-speed protection circuits prevent damage to both the Unit Under Test, and the ***SIRIUS***™ module. In addition, the Current Limit is full programmable to limit Peak Currents for both AC and DC applications. Sensors within each ***SIRIUS***™ module continually monitor circuit temperatures to protect against damage from environmental problems or internal component failures. Any of the fault detection circuits have the ability to disable a module and report any faults to the Oscillator Control Module for communicating the failure.

### Temperature controlled fan speed

To reduce operating noise and power consumption, each ***SIRIUS***™ module's fans are variable speed and functionally controlled to provide on-demand cooling as needed by the individual module.

# Hardware Interface

## Interface Description

### Input/0utput Topology

*Refer to the **DTS**, **UTS** or **UPT** system documentation for the Interface architecture of your **SIRIUS**™*

The ***SIRIUS***™ is typically configured with each channel as a separate source. In a system application (such as an **Autotest Company *UTS-625*** or ***UPT-1000***), this means that each Channel is called a single *Source* and is brought to the system interface in a separate connector. Thus, there are three connectors representing the I/O of a typical 3-channel ***SIRIUS***™ source.

Normally each of these connectors provides all of the connection resources necessary to support a single module, or Channel, independent operation. The application of these channels defines the connection requirements. For proper operation the Remote Sense outputs must be connected to the power conductor outputs at some point between this connector and the product being powered by the ***SIRIUS***™. In addition, the ***SIRIUS***™ interlocks and power configuration resistors for each channel must be connected.

*Refer to the **DTS**, **UTS** or **UPT** system documentation for the Interface architecture of the **SIRIUS**™*

*See* **Appendix A** *for example Interface connections.*

The interlock connections provide the 24V Interlock voltage to operate the source output relays. If this voltage is not provided, the output relays will not close, and there will be no output. The ***SIRIUS***™ will also not program to a voltage. The source of this interlock input should be from the Switched 24VDC output also available on this connector. This voltage is provided from the circuitry within the test system that is controlled by the ***UUT Power*** switch on the system interface panel. If multiple ***SIRIUS***™ modules are to be used in the application, the interlock may be "daisy-chained" through the interlock jumper connections for each channel (usually on pins 41 and 42 of a ***SIRIUS***™ connector).

### Power Configuration Interlock

*See* **Appendix A** *for A list of the Power Configuration Interlocks*

The **Power Configuration Interlock** is provided for additional protection from accidental programming errors placing either the **U**nit **U**nder **T**est (***UUT***) or the ***SIRIUS***™ in a compromised condition. These Application Fixture connections assure the programmed mode of the ***SIRIUS***™ channels matches the intent of the application fixture and **UUT**.

*See the **SIRIUS***™ *programming rules in the **SIRIUS***™ ***Commands** section of this manual.*

The ***SIRIUS***™ firmware strictly monitors these configuration values and rejects with errors any commands that violate the rules of a predefined configuration mode. The basic rule is that output voltages may not be programmed until both software-defined modes match Power Configuration modes, and all prerequisites for a particular mode have been established. Both the Autotest application software and the ***SIRIUS***™ firmware work to protect against inadvertent or incorrect application.

# *SIRIUS*™ Capabilities

## *SIRIUS*™ System Operation

As previously stated, a ***SIRIUS***™ source consists of up to three channels that may be operated totally independent or together. When operated together, the modules may be in parallel for greater power, or synchronized together as in the case of a Three (3) Phase AC Source. The three power module channels are under the control of the Oscillator Control module, which is the source of all waveform definitions and provides the software command interface for ***IEEE488.2*** operation.

*The Configuration protection circuits described in **Power Configuration Interlock** paragraphs above must match the programmed modes.*

Each of the channels may consist of one or more1000-Watt (DC, 750-Watt AC) Power Modules. Multiple Power Modules within a channel are wired parallel to increase the total power capability.

The individual channels of a ***SIRIUS***™ may be software configured to produce output waveforms of any shape from DC to a user defined arbitrary wave-shape. The voltages of these wave shapes are also programmed in either Peak or RMS values as needed to achieve the desired outputs.

*See* **Appendix A** *for the Power Configuration Interlock definitions.*

If power beyond the ability of an individual channel is required, multiple channels may be connected and programmed in Parallel at the discretion of the user. If multiple AC voltage and power arrangements are needed, multiple channels may be synchronized together with individual wave shapes and relationships to produce power source characteristics such as Line-to-Line AC, Three Phase AC, or Buck-Boost arrangements. In all of these cases, the user has complete control over the wave shapes being output, and the individual voltages programmed.

# Independent Module Operation

## AC Independent Mode

*See* **Appendix A** *for the Power Configuration Interlock of AC Independent.*

As a totally independent AC channel, each of the tree ***SIRIUS***™ channels may operate in every regard independently. They may have different waveforms, different frequencies, different voltages, and isolated ground references. Each may be considered a separate AC Source. When operating in AC Independent mode, the only relationship the three channels have is that they are under the control of a single Sirius Oscillator Control module. In this regard, only Reset and Inhibit affect all modules together (see the *SIRIUS*™ Command ***INHibt*** and ****RST***).

In AC mode, there are many options of AC waveforms. Three sine waveforms are internally defined, where the only difference between them is there phase relationship. What **APG for Windows**™ calls waveforms ***Phase A***, ***Phase B***, and ***Phase C***, and ***SIRIUS***™ calls waveforms ***0***, ***1***, ***2***, are identical sin waveforms defined by 1800 points in the waveform registers. The only difference being waveform 0 is synchronized to begin at the zero crossing point, Waveform 1 begins at the 120˚ point of the waveform, and Waveform 2 begins at the 240˚ point of the waveform. If the three channels of a ***SIRIUS***™ operate synchronized together, with each operating on a different one of these waveforms, they would become a Three Phase AC Source. Any of these waveforms may also be used on any channel in AC mode.

*Refer to the **WAVeform** command in the **SIRIUS™ Commands** section of this manual.*

A forth version of this same sine wave is available in the special case of Waveform 3 (or ***V*** in **APG for Windows™**), were the phase relationship to beginning at zero crossing may be programmed in degrees. For a Three Phase Source, this waveform may be substituted for any or all of the other three waveforms to allow programmable phase relationships.

*Refer to the **DATa** command in the **SIRIUS™ Commands** section of this manual.*

For user defined AC waveforms, there are 156 waveform registers, with 1800-points each, available to accept them. The wave shapes may be described by either entering data directly into the registers, or be downloading a data file to a register.

## DC Independent Mode

*See* **Appendix A** *for the Power Configuration Interlock of DC Independent*

In DC Independent mode, the ***SIRIUS™*** module utilizes special waveforms that are set to the maximum of the waveform register (3fff hex). When setting values of DC voltage, the Peak voltage is the value actually programmed. Any variable DC voltages required are actually considered AC, and should use the AC waveform registers mentioned earlier. Refer to the commands section for more detail on waveform definitions.

***DC Application Caution!***

When operating a ***SIRIUS™*** module in DC mode there are two additional considerations necessary. Since the ***SIRIUS™*** is a direct "H-Bridge" output, the value of zero volts is a regulated setting, just as any other value programmed. The ***SIRIUS™*** is going to attempt to force this voltage by either sinking or sourcing current. In a test system the ***SIRIUS™*** output is isolated by relays that are automatically opened when the ***SIRIUS™*** is programmed to zero using the ATE software **APG for Windows™**. Programming the ***SIRIUS™*** voltage outside of **APG for Windows™** bypasses this control and can be hazardous to ***SIRIUS™***.

In addition, because of this output characteristic, voltages should not be "back-feed" into a ***SIRIUS™***. If the ***SIRIUS™*** application expects to have higher voltage present at the ***SIRIUS™*** output, blocking diodes should be used to protect it. Also, the remote sense pins of the ***SIRIUS™*** should not be connected beyond these diodes.

***DC Current Limit!***

*Refer to the **CL** command in the **SIRIUS™ Commands** section of this manual.*

Another consideration is with the use of Current Limit programming. The current limit of a ***SIRIUS™*** module is programmed in percent (***%***) of full scale ***Peak Current***. As is stated in the module specifications, the full scale ***Peak Current*** is 52.6 amps. This sets the maximum current that may be delivered instantaneously by the module. In DC Mode, this should not be set to the average maximum value. If the DC current has an AC component (such as with a DC to AC converter), the voltage will drop when the ***SIRIUS™*** goes into current limit at the peak current values. Current limit will also limit the *Inrush* current that may be delivered by the ***SIRIUS™*** module.

## Parallel Mode

*See* **Appendix A** *for the Power Configuration Interlock of AC or DC Parallel.*

If a ***SIRIUS™*** configuration provides multiple modules per Channel, no special application consideration is necessary. Each Channel is preset to function in parallel, and will deliver the multiples of current and power relative to the number of modules provided. If more power or current is needed than can be delivered by an individual Channel, the Channel outputs may be wired in parallel to support the increase. Connect all of the modules sense and output pins to the load, and set the Power Configuration for the appropriate paralleled configuration.

*Refer to the* ***PARallel*** *command in the* ***SIRIUS™ Commands*** *section of this manual.*

Also, don't forget to define in software the intent of using parallel operation. Remember that when you configure channels to be in parallel, all commends sent must be addressed to them as a set. They are considered one operating entity, and all functionality must be done in concert. When programming a ***SIRIUS™*** using **APG for Windows™** commands, it is recommended that the composite statement which sets all ***SIRIUS™*** items together be used (Refer to **Sirius One Configuration** or **Set Sirius Configuration** in the ***APG for Windows™ Control*** section).

***Note: To assure the Current Limit of the set is programmed correctly, remember to reset it after the parallel configuration is implemented.***

## Synchronized Independent Mode

*See* **Appendix A** *for the Power Configuration Interlock of AC or DC Parallel.*

Any modules that are defined in Parallel as described about are automatically synchronized. This means that they are operating from the same clock cycle for waveform replication. An additional synchronization mode that is commonly used is Three Phase. In standard Three Phase power, the relationship of the three sin waves is strictly controlled to assure they maintain a 120˚ separation. The appropriate Power Configuration for this mode is AC Independent on all Channels.

*Refer to the* ***SOUrce*** *command in the* ***SIRIUS™ Commands*** *section of this manual.*

Three Phase is a special case of synchronization supported in **APG for Windows™** configuration. This configuration also links the three Channels together in programming so that all are programmed together. The ***SIRIUS™*** automatically accepts programming any combination of Channels at the same time, as long as they are configured properly, but **APG for Windows™** only supports this in Three Phase and Parallel. Different waveforms may also be configured for each Channel to attain the desired phase relationships in the Three Phase configuration.

## Individual Channel Specifications

Each of the channels may have more than one ***SIRIUS™*** module attached based on the configuration of a particular test system. The specifications provided in this section are for that of a single module channel. If there are multiple modules installed, the below power and current specifications are multiplied by the number of modules.

***SIRIUS™* Module Specifications**

| | | |
|---|---|---|
| **Rated Power** | | 750Watts |
| **Voltage Programming** | | |
| | Range | 0 – 282VAC RMS, 0 – 400VDC |
| | Resolution | 18mV for AC, 25mV for DC |
| | Accuracy | 0.1% (DC and freq < 400Hz), 0.2% (freq < 1kHz) |
| **Max Current** | | |
| | RMS | 15 AAC |
| | Peak | 52.6 A PK |
| | DC | 15 ADC |
| **Current Limit Programming** | | |
| | Resolution | 1 % Peak Full Scale |
| | Accuracy | 1 % Peak Full Scale |
| **AC Frequency Programming** | | |
| | Range | 0.017Hz – 833Hz (1800 step internal waveform)<br>0.085Hz – 4166Hz (360 step external waveform) |
| | Resolution | 0.013Hz (1800 step internal waveform)<br>0.066Hz (360 step external waveform) |
| | Accuracy | 0.01% |
| **AC Phase Shift Programming** | | |
| | Resolution | 0.2 Degrees |
| | Accuracy | 0.2 Degrees |
| **Disturbance Programming** | | |
| | Number of Events | 3 per Channel |
| | Duration Range | 0 – 65.5 mS |
| | Duration Resolution | 1µS |
| | Duration Accuracy | 0.05 mS |
| **Parallel Current Sharing Imbalance** | | < 2% of Full Scale or 0.3A |
| **Total Harmonic Distortion** | | |
| | < 400Hz | 0.2% |
| | 400Hz -1KHz | 0.5% |