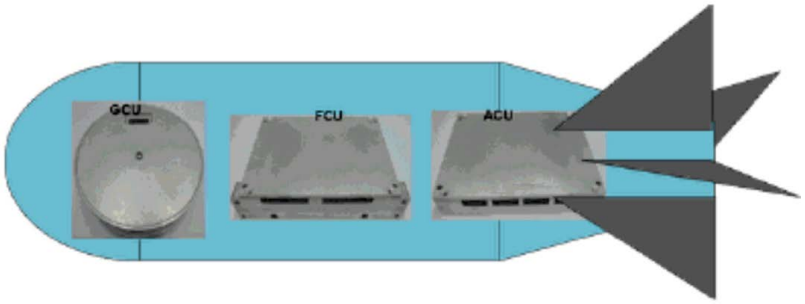
PARK CGE

Control & Guidance Electronics System

PARK CGE is a Control and Guidance Electronics System (CGE) is designed for laser guided bombs, to enable the bomb to precisely seek the target. The target is illuminated with a laser beam while the bomb is dropped. With the help of a laser seeker mounted inside the bomb, the CGE guides the bomb towards the laser beam illuminating the target, compensating for the drifts caused by the initial horizontal velocity of the bomb, wind velocity and direction and other errors in the initial launching of the bomb.



- GCU: Guidance Control Unit
- ACU: Actuator Control Unit
- FCU: Flight control unit

The GCU is mounted in the nose of the Bomb and interfaces to a four quadrant laser detector mounted on gimbals. It receives the four quadrant electrical signal outputs from the laser detector and controls the gimbals such that the laser detector output is maximized. Further, it passes the azimuth and elevation errors computed from the laser detector outputs to the FCU.

The FCU forms the core control unit for the CGE system. It has a MIL1553B interface, via which the target coordinates and the coordinates of the point from which the bomb is dropped are loaded from the aircraft.

The FCU based on this initial information and the azimuth/elevation error signals received from the GCU computes the correct direction in which the bomb has to move, and gives commands to the ACU to deflect the tail fins of the bomb properly to move it towards the target.

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The PARK CGE electronics is a complex multitasking system performing several data acquisition, computation, control and communication tasks simultaneously. Most of the control, communication and data acquisition tasks are implemented in FPGAs to achieve sub microsecond processing latencies. DSP processors are used to support the FPGAs in computations where necessary. Functions like actuator motor control, Gimbal motor control, four quadrant detector output signal processing, high speed communications with INSGPS, intersubsystem communications, telemetry data transmission etc., are handled fully by the hardware blocks implemented in FPGAs, operating in parallel. Ethernet communications with diagnostic PC, MIL1553B communication, storage and initialization of configuration parameters, reading mission data from USB port are vandled by embedded processors in the FPGA.

Flight Control Unit (FCU): The FCU performs the following key functions.

- Power regulation and distribution: The FCU receives 28V DC power simultaneously from aircraft, thermal battery, an auxiliary lithium battery and determines which source of power to be used. It distributes this power to ACU and GCU for their use and locally generates all the logic and analog supplies required for its operation.
- Mission data interface over 1553B and RS422 links: The FCU can be configured as a 1553B bus monitor or RT to receive mission data parameters from the aircraft. This data can alternately be received via a RS422 link if the FCU is configured so.

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- INSGPS interface: The current position of the bomb is received through this interface. The position and velocity information received from the aircraft via the 1553B bus is used to synchronize the INSGPS, at thetime of release of the bomb.
- USB interface for mission data load: A USB port is provided to feed the mission information, like target position and laser code using a USB memory stick. However the information loaded from the USB stick, can be overridden by commands received over the 1553B bus.
- Ethernet interface for code down loading and diagnostics: Code down loading and diagnostics and ground checks are possible for the complete CGE system using a PC loaded with appropriate utilities through the Ethernet.
- Telemetry data link with pre-modulation filtering: The health of various subsystems, power supply voltages, status of critical signals (like release sense, thermal battery firing, impact sense), the four quadrant output voltages of the laser detector, the azimuth and elevation errors computed by the GCU, current fin positions received from the ACU, key watch variables etc., are transmitted on the PCM telemetry link. A built in premodulation filter is provided, enabling the PCM output from the FCU to be directly connected to the input of a FM transmitter.
- ACU communication link: A high speed RS422 communication link with the ACU allows exchange of diagnostics, code down loads, commands, current fin positions and other status information with ACU.
- GCU communication link: A high speed RS422 communication link with the GCU allows exchange of diagnostics, code down loads, commands, current laser detector output voltages, gimbal positions, etc., with the GCU.
- Impact firing circuit: This circuit is triggered when the bomb hits the target, to initiate any post impact activities.

Guidance Control Unit functions:

- Laser signal processing: The four quadrant outputs of the laser signal detector are continuously sampled by the GCU using high speed A/ D converters. The GCU has the capability to lock to the correct laser code, when multiple laser codes are simultaneously present. The GCU searches for the correct laser code using the laser code period parameter that has been configured and locks onto the correct laser code. Once it has locked to the required code, four quadrant detector outputs available during the occurrence of correct laser pulse only are processed and outputs during other periods are rejected.
- Gimbal control: Based on the laser code to which the GCU has locked and the elevation and azimuth errors computed, the GCU controls the gimbal motors to orient the four quadrant laser detector so that as to maximize the signals detected by the four quadrant detector corresponding to the designated laser code. This task is performed by a DSP incorporated in the GCU.
- FCU communication: It keeps transmitting information of the four quadrant detector output voltages, whether it has locked on to the correct laser code, the gimbal motor positions, etc.

Actuator Control Unit functions:

- Fin control: The actuator unit controls the deflections of the fins, based on commands received from FCU. There are four fins controlled by four three phase BLDC motors, which are driven by the ACU using internal PID algorithms and three phase H-bridge drivers, to provide suitable fin deflection. Hall effect sensors built into the motors provide feedback regarding the current position of the motor and which of the phases has to be switched on. The Optical position encoders built into the motors provide pulses to the ACU to monitor the direction of motion and relative angle of rotation. The ACU by algebraically summing these pulses and scaling them for the gear ratio keeps track of the current position of the fins.
- FCU communications: The ACU continuously receives fin position update commands from the FCU and responds to the FCU by transmitting updated fin positions at the end of each command. Four FPGAs implemented PID controllers control the four BLDC fin motors simultaneously.

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PARK CGE Specifications: Actuator Control Unit (ACU):

No. of actuator motors supported :	4
Type of motor supported :	Three Phase BLDC
Motor Supply Voltage :	28V Max
Maximum continuous current/motor :	3A
Motor position sensing :	Two phase optical encoder
Motor controller :	FPGA based PID algorithms
Flight control Unit Interface :	Rs422
Operating voltage :	28V ± 4V DC
Power consumption (without motors) :	10 Watts (Typical)
Operation temperature :	-40° C to +71° C
Dimensions :	170mmx130mmx30mm approx.

Guidance Control Unit (GCU): Quadrant detector inputs:

No of inputs :	4
Minimum laser pulse width :	20ns
Laser code programmability :	45ms to 55ms
Minimum laser signal amplitude :	10mV
Maximum laser signal amplitude :	3.0V
Number of Gimbal motors supported :	2
Gimbal position sensing :	Potentiometric
Gimbal position sensor excitation :	2.5V
Immunity to interfering laser codes :	Can detect correct code in presence of four spurious codes
Required laser code accuracy :	-±10 micro seconds of the nominal code period
FCU interface :	Rs422
Operating voltage :	28V ± 4V DC
Power consumption(without motors) :	10 Watts (Typical)
Operation temperature :	-40° C to +71° C
Dimensions :	120 mm Dia x 50 mm height (approximate)

Flight Control Unit (FCU):

Input Power Supply range :	18V to 36V
Input Power supply sources :	External power input for ground checkout Aircraft Power supply during transport Auxiliary Battery after release before thermal battery take over Thermal Battery during deployment
Firing signals :	Release sense input, Thermal battery firing output, Impact sense input, Impact firing output
Aircraft interfaces :	RS422, MIL 1553B
Mission data loading :	USB interface/ Aircraft interface
Navigation input :	RS422 interface for external INSGPS
GCU Interface :	RS422 with cable sense, impact sense
ACU interface :	Rs422
Code down loading/diagnostics :	Ethernet/RS232
Power consumption (without motors) :	15 Watts (Typical)
Operation temperature :	-40° C to +71° C
Dimensions :	194mmx133mmx45mm (approximate)

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