Evans Capacitor Company is a privately owned small business. We are a direct supplier to all Tier 1 defense contractors, ITAR Registered and AS9100/ISO2001 Certified. Incorporated in 1996, 2016 marks our 20th anniversary.

- All products manufactured by ECC in USA
- All products are designed in house & built to order
- All units are 100% electrical tested & certified
- All units carry unique S/N for identification
HIGH POWER PULSE APPLICATIONS

- PHASED ARRAY RADAR
  - GaN
  - GaAs

- JAMMING SYSTEMS
  - NGJ
- EW SYSTEMS
  - Directed Energy

LMCO- MEADS
NGC- Cobra Judy Replacement
Raytheon - NGJ
NGC- E2D
Boeing / NGC - Wedgetail
Why do we need High Power & Energy Storage?

“T/R modules, for defense radars, typically have high power amplifiers that require significant DC power during the transmit cycle of operation.....Each T/R module has a bank of capacitors to store energy that can help supply current during the transmit pulse to minimize voltage droop during the pulse. Voltage droop equates to RF power droop. Power conditioning is especially critical for long pulse waveforms.”


C1 capacitor provides the energy required to drive the pulse. 75% to 90% of the pulse power must be stored here.
GaN and GaAs on SiC (and diamond) can enable very high power T/R modules for modern phased array radars and other systems with 600w, 800w, and 1,000w designs.

Jamming and EW systems work in similar ways, demanding high power pulses to deliver jamming signals, EM bursts, etc.

These systems need very high power pulses to transmit and must maintain that power throughout the pulse without voltage droop.
Additionally . . .

• GaN and GaAs on SiC (and diamond) enable very compact designs for T/R modules.
• New phased arrays, especially airborne, are much smaller and more powerful than previous technology allowed.
• Jamming and EW systems may be external pod configurations

Challenges . . .

• Highest power
• Most compact designs

We need . . .

New technology, high power energy storage to maximize performance, efficiency, and volumetric utilization.
HIGH POWER PULSE APPLICATIONS

Why Space and Weight matter

NGC- E2D
Radar and Jammers - How do we provide all that power?

- Higher operating voltage - 48V or 50V
- High current >20A
- Wider pulse width – 100µSec to mSec
- Aggressive duty cycles > 10%
HIGH POWER PULSE

- LASER TARGETING
- EW SYSTEMS
  - LASER Weapons
- RESEARCH LASERS
- LIDAR

APPLICATIONS

JSF EOTS

NASA LIDAR

HAPLS LASER Diode array

LLDR – targeting rangefinder
LASERs and such - How do we provide all that power?

- Higher operating voltage - 50V to 500V
- High current 200A – or more!
- Narrow very sharp pulse – 1 to 5µSec
- light duty cycles
In Defense, Airborne, & Space systems for very high power our energy storage must . . .

- Provide sufficient energy to power the pulse
- Absorb high ripple current
- Filter voltage overshoot
- Cycle efficiently for life of system

With

- Minimum weight and volume
- Performance over temperature range
- Excellent heat transfer
- Very high reliability
Two electrodes are connected in series by an electrolyte.
- \( \text{Ta}_2\text{O}_5 \) dielectric (anode) withstands high voltages.
- High capacitance \( \text{RuO}_2 \) (cathode) increases volumetric efficiency.
- Liquid electrolyte – formulated for high reliability and long life.

\[ CcVc = Q = CaVa \]
HYBRID CAPACITOR
TECHNICAL ADVANTAGE

• High cell voltage – no series connections (up to 125V)
• Low Resistance
• Low time constant
• High specific power and energy
• Wide temperature range (-55°C-125°C with some to 200°C)
• Fast recharge time
• Unlimited Cycle Life
• Unlimited Shelf Life
• High Reliability
HYBRID CAPACITOR CONFIGURATION
Phase 1 - THQ

THQ3

PTFE Insulator(s)

TaO5 Anode(s)

Separator(s)

RuO2 Cathode deposited on Ta Foil
HYBRID CAPACITOR
DEVELOPING Higher Power
Phase 2

Phase 2 – Increase cap without adding to height or footprint

THQ SERIES
CUSTOMER REQUIRED
MORE POWER, BUT
OFFERED NO
ADDITIONAL SPACE

THS SERIES: BY FILLING IN
THE CORNERS WE WERE
ABLE TO OFFER 1/3 MORE
CAPACITANCE IN THE SAME
FOOTPRINT
HYBRID CAPACITOR
CUSTOMER DRIVEN DESIGN

Phase 1 – AC Results
Phase 3 – REDUCE ESR

**THS SERIES:**
80V 10mF 40mΩ max
Customer needed lower resistance to reduce cooling requirements during high power duty cycling.

**TDD SERIES:**
80V 9mF 18mΩ max
A COMBINATION OF IMPROVEMENTS AND DIRECT CUSTOMER INPUT LEAD US TO THE “DAVE’S DREAM”
THS / TDD CAPACITOR CONFIGURATION

THS3

TDD2

(+) connection
THS / TDD CAPACITOR CONFIGURATION

THS3 Internal Configuration

TDD2 Internal Configuration
HYBRID CAPACITOR
CUSTOMER DRIVEN DESIGN

Phase 2 – AC Results
HYBRID CAPACITOR RELIABILITY

• Life is > 2,000 Hrs at Rated Voltage & 85°C
• Life is > 2,000 Hrs at 60% Rated Voltage & 125°C
• MTBF > 5,000,000 Hrs - High current pulse power (qualification test for E2D)
• MTBF > 30,000,000 Hrs – in service life on Apache Arrowhead
• TDD Cycle test for LLNL – 6 Billion Cycles over 231 days
• TDD Radar Qualification >3,000hrs with temp cycles, at full power
• Over 400,000 Hybrid Capacitor units sold since 2001
• Routinely specified, screened and qualified for space applications
  • Incorporating EEE-INST-002 guidelines
Flight Qualification TDD2
3000 to 5000 hrs
Temp cycling environment
35 Amp pulse
Duty cycle > 10%
500 to 1,000 Hz
Expected to be end of life
PDA revealed pristine components
No age related deterioration
EVANSCAPS™
Advanced Capacitors for Demanding Applications!

- Highest Power Density
- Large Capacitance
- Very High Current Handling
- Unlimited Shelf Life
- Unlimited Cycles
- Most Efficient
- Very Low ESR (even at low temp)
- Fully Hermetic
- Excellent Heat Transfer
- High Reliability

80V 6,000μF
< 0.027Ω 13cc 86g

Pictured: TDD2080602SM01

www.evanscap.com • chasd@evanscap.com