



MOHAMED SATHAK AJ COLLEGE OF ENGINEERING

(Approved by All India Council for Technical Education,
New Delhi and affiliated to Anna University, Chennai)
Siruseri IT Park, Egattur, Chennai - 603 103

Bharat Forge Limited – MSAJCE R&D works

Design of Electromagnetic Launcher for Propelling Projectile

Report

PRINCIPAL
MOHAMED SATHAK A.J. COLLEGE OF ENGINEERING
34, Rajiv Gandhi Road (OMR), Siruseri, Chennai-603 103.



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Design of Electromagnetic Launcher for Propelling Projectile

Abstract:

Pulsed power supply system (PSS) plays an important role in rail gun system as it gives an electrical energy to rail gun in order to accelerate the projectile with higher velocity. Now-a-days the pulsed power supply system which feed the rail launcher is still large and it is important to think about the minimization of the stored energy. The pulsed power supply system that has well enough small mass and volume, yet can offer properly conditioned power, is a vital component for the successful accomplishment of rail gun system. All embracing works and researches are being carried out all over the world for the minimization of the volume occupied by the power supply and its weight. Capacitor based pulsed power supply systems are the most familiar form of pulsed power supplies system used in rail gun research for the past several years. The design of a 500kJ capacitor module pulsed power system, which can able to accelerate the projectile with a velocity of 1km/s to 1.5km/s, to be applied for the electromagnetic rail gun currently under investigation in India for surface fire support. We made an attempt to design a 500kJ PPS using computer simulation packages called PSPICE software in order to calculate the rail gun parameters such as acceleration of the projectile, muzzle velocity, peak current, current at exit, effective barrel length. Finally, this work gives some fundamental contemplation on volume and weight requirements of 500kJ capacitive PPS systems to be applied for speedy fire of electromagnetic rail guns. With the PSPICE simulation design & results, rail dimensions and PPS was provided for the procurement and fabrication. Residual charge after one shot in the rails was considered. Based on single shot results decision on multi-shot operation was made. Electromagnetic launcher was tested for its weight and velocity.

Keywords: electromagnetic; Pulsed power; PSPICE; rail gun

Components list:

Components used in pulsed power supply system with rail gun load are listed below

S.No.	Component	Values
1	Capacitor	2.3685mF
2	Inductor	Varying Inductor
3	Spark gap	Operating Voltage =50kV; Peak Current = 500kA
4	Diode	Peak Reverse Voltage & Current VRRM = 6000V; IRRM=100mA
5	Fuse	Rated pulse current 6000A, Voltage 22kV
6	L' of the rail	1.096 μ H/m

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Benefits:

- Occupies less space,
- Has less weight,
- High operational reliability,
- Feasible financial condition,
- High power density, and
- High durability

Results and Discussion:

500kJ pulsed power supply system that can be used in electromagnetic rail gun system has been designed using PSPICE simulation packages. Trade off study has been made to find the optimum number of capacitor stages to get desired current pulse shape and rail parameters. In order to identify optimum solution for 500kJ PPS, capacitors have been grouped into single, double, triple and five stages. For each capacitor connection pulse shaping inductance value, peak current value, current at exit, muzzle velocity, peak acceleration value, pulse width, effective barrel length of the rails have been calculated. It has been observed that an increase in number of stages in a capacitor bank module causes an increase in value of pulse width time, muzzle velocity of projectile, the time at peak current value, effective barrel length of the rails, current at exit and decrease in value of peak current and peak acceleration. It has been concluded that the 500kJ pulsed power supply can be able to accelerate a projectile at a velocity of 1.2km/s, when the capacitor banks are fired before reaching peak level current of previous bank. The work has also been carried out to calculate the approximate weight and volume occupied by the pulsed power supply using the manufactured data's. It has been concluded that the 500kJ pulsed power supply needed 0.6686 m³ of volume with a total weight of 620kg.

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PROFORMA INVOICE

From
Dr.K.S.Srinivasan
Principal
Mohamed Sathak A.J. College of Engineering
SIPCOT – IT Highway
Chennai – 603 103

20.03.2020

To
Dr.RAJKUMAR P. SINGH
Senior Director,
Kalyani Centre for Technology & Innovation,
Bharat Forge Limited,
Pune Cantonment,
Mundhwa,
Pune – 411 036

Sub: Proforma Invoice for the Consultancy Work “Design of Electromagnetic Launcher for Propelling Projectile of 10g at 1 to 3 Mach” – Reg

S.No	Project Descriptions	Amount (Rupees)
1	Consultancy charge for PSPICE simulation. (Selection of Capacitor, Inductance, Diode, Thyristor, Injector Circuit, Measurement of Velocity, Acceleration and Length of the rails)	1,00,000
2	Consultancy charge for ANSYS simulation. (Current density distribution, Magnetic flux density distribution, Temperature distribution over rail and armature, Selection of rail shapes and Dimensions)	75,000
3	Institution charge	25,000
TOTAL		2,00,000

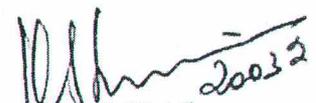
(Rupees Two Lakh Only)

It is requested that the balance amount of Rs.1,00,000/- (Rupees One Lakh Only) may kindly be issued.



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MOHAMED SATHAK A.J. COLLEGE OF ENGINEERING
No. 34, Rajiv Gandhi Road, (OMR) SIPCOT - II Rd
Siruseri, Chennai - 603 103.

FORM NO. 16A

[See rule 31(1)(b)]

Certificate under section 203 of the Income-tax Act, 1961 for tax deducted at source

Certificate No. IEZLYFB		Last updated on 14-Feb-2019		
Name and address of the deductor		Name and address of the deductee		
BHARAT FORGE LTD ADMIN. BUILDING, PUNE CANTONMENT, MUNDHWA, PUNE - 411036 Maharashtra +(91)20-67042410 sanjay.vibhute@bharatforge.com		MOHAMED SATHAK TRUST PYCROFTS GARDEN ROAD, THOUSAND LIGHTS, CHENNAI - 600006 Tamil Nadu		
PAN of the deductor	TAN of the deductor	PAN of the deductee		
AAACB8519L	PNEB00007A	AAATM0652J		
CIT (TDS)		Assessment Year	Period	
The Commissioner of Income Tax (TDS) 4th Floor, .A. Wing, PMT Commercial Complex, Shankar Sheth Road , Swargate, Pune - 411037		2019-20	From 01-Oct-2018 To 31-Dec-2018	
Summary of payment				
Sl. No.	Amount paid/ credited	Nature of payment**	Deductee Reference No. provided by the Deductor (if any)	
1	200000.00	194J		
Total (Rs.)	200000.00		Date of payment/ credit (dd/mm/yyyy) 14-12-2018	
Summary of tax deducted at source in respect of Deductee				
Quarter	Receipt Numbers of Original Quarterly Statements of TDS Under sub-section (3) of Section 200	Amount of Tax Deducted in respect of Deductee	Amount of Tax Deposited / Remitted in respect of Deductee	
Q3	QTKSLDMF	20000.00	20000.00	
I. DETAILS OF TAX DEDUCTED AND DEPOSITED IN THE CENTRAL GOVERNMENT ACCOUNT THROUGH BOOK ADJUSTMENT (The deductor to provide payment-wise details of tax deducted and deposited with respect to the deductee)				
Sl. No.	Tax deposited in respect of deductee (Rs.)	Book Identification Number (BIN)		
		Receipt Numbers of Form No. 24G	DDO serial number in Form No. 24G Date of Transfer voucher (dd/mm/yyyy) Status of Matching with Form No. 24G	
Total (Rs.)				
II. DETAILS OF TAX DEDUCTED AND DEPOSITED IN THE CENTRAL GOVERNMENT ACCOUNT THROUGH CHALLAN (The deductor to provide payment-wise details of tax deducted and deposited with respect to the deductee)				
Sl. No.	Tax deposited in respect of the deductee (Rs.)	Challan Identification Number (CIN)		
		BSR Code of the Bank Branch	Date on which tax deposited (dd/mm/yyyy)	Challan Serial Number Status of matching with OLTAS*
1	20000.00	0510075	07-01-2019	30906 F
Total (Rs.)	20000.00			
Verification				
I, VIRENDRA UPENDRA KALE , son / daughter of UPENDRA GANGADHAR KALE working in the capacity of VICE PRESIDENT (designation) do hereby certify that a sum of Rs. 20000.00 [Rs. <u>Twenty Thousand Only</u> (in words)] has been deducted and a sum of Rs. 20000.00 [Rs. <u>Twenty Thousand Only</u>] has been deposited to the credit of the Central Government. I further certify that the information given above is true, complete and correct and is based on the books of account, documents, TDS statements, TDS deposited and other available records.				

Place	PUNE	(Signature of person responsible for deduction of tax)
Date	27-Feb-2019	
Designation: VICE PRESIDENT		Full Name: VIRENDRA UPENDRA KALE

Notes:

- Form 16A contains the latest transaction reported by the deductor in the TDS / TCS Statement. For further details please view your 26AS for same AY on the website <https://www.tdsepc.gov.in>
- To update the PAN details in Income Tax Department database, apply for 'PAN change request' through NSDL or UTITSL.
- In items I and II, in column for tax deposited in respect of deductee, furnish total amount of TDS, surcharge (if applicable) and education cess (if applicable).

Legend used in Form 16A*** Status of matching with OLTAS**

Legend	Description	Definition
U	Unmatched	Deductors have not deposited taxes or have furnished incorrect particulars of tax payment. Final credit will be reflected only when payment details in bank match with details of deposit in TDS / TCS statement
P	Provisional	Provisional tax credit is effected only for TDS / TCS Statements filed by Government deductors. "P" status will be changed to Final (F) on verification of payment details submitted by Pay and Accounts Officer (PAO)
F	Final	In case of non-government deductors, payment details of TDS / TCS deposited in bank by deductor have matched with the payment details mentioned in the TDS / TCS statement filed by the deductors. In case of government deductors, details of TDS / TCS booked in Government account have been verified by Pay & Accounts Officer (PAO)
O	Overbooked	Payment details of TDS / TCS deposited in bank by deductor have matched with details mentioned in the TDS / TCS statement but the amount is over claimed in the statement. Final (F) credit will be reflected only when deductor reduces claimed amount in the statement or makes new payment for excess amount claimed in the statement

**** Nature of Payment**

Section Code	Description	Section Code	Description
193	Interest on Securities	195	Other sums payable to a non-resident
194	Dividends	196A	Income in respect of units of non-residents
194A	Interest other than 'Interest on securities'	196B	Payments in respect of units to an offshore fund
194B	Winning from lottery or crossword puzzle	196C	Income from foreign currency bonds or shares of Indian company payable to non-residents
194BB	Winning from horse race	196D	Income of foreign institutional investors from securities
194C	Payments to contractors and sub-contractors	206CA	Collection at source from alcoholic liquor for human consumption
194D	Insurance commission	206CB	Collection at source from timber obtained under forest lease
194E	Payments to non-resident sportsmen or sports associations	206CC	Collection at source from timber obtained by any mode other than a forest lease
194EE	Payments in respect of deposits under National Savings Scheme	206CD	Collection at source from any other forest produce (not being tendu leaves)
194F	Payments on account of repurchase of units by Mutual Fund or Unit Trust of India	206CE	Collection at source from any scrap
194G	Commission, price, etc. on sale of lottery tickets	206CF	Collection at source from contractors or licensee or lease relating to parking lots
194H	Commission or brokerage	206CG	Collection at source from contractors or licensee or lease relating to toll plaza
194I	Rent	206CH	Collection at source from contractors or licensee or lease relating to mine or quarry
194I(a)	Payment of Rent for the use of any machinery or plant or equipment	206CI	Collection at source from tendu Leaves
194I(b)	Payment of Rent for the use of land or building or land appurtenant or furniture or fittings	206CJ	Collection at source from on sale of certain Minerals
194J	Fees for professional or technical services	206CK	Collection at source on cash case of Bullion and Jewellery
194K	Income payable to a resident assessee in respect of units of a specified mutual fund or of the units of the Unit Trust of India	206CL	Collection at source on sale of Motor vehicle
194LA	Payment of compensation on acquisition of certain immovable property	206CM	Collection at source on sale in cash of any goods (other than bullion/jewelry)
194LB	Income by way of Interest from Infrastructure Debt fund	206CN	Collection at source on providing of any services (other than Ch-XVII-B)
194LC	Income by way of interest from specified company payable to a non-resident		
194LBA	Certain income from units of a business trust		
194LBB	Income in respect of units of investment fund		
194LBC	Income in respect of investment in securitization trust		



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Signature Not Verified

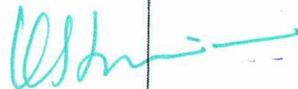
Digitally signed by
VIRENDRA UPENDRA KALE
Date: 2019.02.27 09:59:12
IST

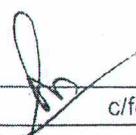
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NO.34, RAJIV GANDHI ROAD, (OMR), SIRUSERI, EGATTUR, CHENNAI - 603103

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2019

Last year	EXPENDITURE	Rs. P.	Last year	INCOME	Rs. P.
1047760	To Admission Expenses	320109.00	84050	By Application fees	77100.00
1440586	Advertisement	459175.00	8496418	Bus fees	6669500.00
865035	Affiliation & Approval fee	721583.60	8209100	Certified Courses fee	3063500.00
86629	Bank charges	19373.03	26453200	Hostel fees	16588435.20
			172600	Insurance fees	
24329859	Depreciation	24162289.99	524747	Interest received	44552.47
5744755	Diesel Expenses	6549925.00	51378	Library fine	0.00
12000	Donation	0.00	-45150	Mess fees	248000.00
12000	Driver Bata	13315.00	762713	Miscellaneous fee	143830.00
3664583	Electricity charges	4099379.00	3944500	Note Book fee	676000.00
78809	Electrical Maintenance	0.00	16145100	Other fees	8927600.00
40000	Enterpren Develop.Progra	15000.00	15000	Scrap Sales	0.00
1421241	ESI	1027420.00	43289775	Tuition fees	32861222.00
3321333	EPF	5475437.00	0	Damage claim	304800.00
504395	Examination Fee & Exp	4946932.00	0	First gradn. Tuition fee	4880000.00
325930	Electricity - Ladies Hostel	0.00	0	Misc. Income	179268.00
901381	Function & Celebration	962488.00	0	Research & Consultancy	255200.00
158750	Fee refunded	8408000.00	0	Mst Scholarship	5565000.00
15400	Generator Expenses	0.00	26804814	Excess of Expendr. over	
184900	Guest Lecture Expenses	73802.00		Income	70543520.71
1299727	Hostel Expenses	8905.00			
3567126	House Keeping Expenses	3864657.00			
1133081	Insurance - Vehicle	1561971.00			
38670	Internet charges	46551.00			
	Lab Equipment - Mechanic	106800.00			
0	Laboratory Consumables	119200.00			
67000	Legal expenses	20000.00			
274185	Maintenance - R.O.Plant	715.00			
400000	Maintenance - Ground	0.00			
2277466	Maintenance - Vehicles	4441782.66			
217350	Maintenance - Computer	0.00			
420	Maintenance - Civil lab	16050.00			
23828	Membership fees	0.00			
12927833	Mess Expenses	13198845.00			
1279258	Miscellaneous expenses	1750883.60			
108081	News Papers & Journals	94481.00			
100000	Note Books & Uniform	1254572.00			
954973	Office Maintenance	0.00			
51793	Petrol Expenses	0.00			
21526	Postage & Couriers	21861.00			
458383	Printing & Stationery	1175584.00			
278651	Professional Tax	170911.00			
32281	Property Tax	0.00			
143257	Rates,Taxes & Fees	4970.00			
164490	Rent - Bus parking	143750.00			
742129	Repair & Maintenance	2078207.00			
396459	Road Tax	387428.00			
54156831	Salary & Allowances	48378132.00			
2683745	Security Salary	3666281.00			
373780	Sports & Extra Curriculars	0.00			
1237874	Staff Welfare Expenses	218485.00			
10139	Staff Development	13900.00			
188500	S.T.P	386730.00			
69083	Students Insurance	0.00			
131045619	c/fd	140437900.88	134908245	c/fd	151027528.38


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31045619	b/fd	140437900.88	134908245	b/fd	1510275
27200	Seminar & Symposium Exp	100000.00			
42480	Software expenses	0.00			
209216	Solar power expenses	181389.50			
2543420	Student Devt. Activities	1262425.00			
4000	Sponsors expenses	29166.00			
61915	Telephone Charges	83455.00			
484646	Toll Gate fees	494735.00			
177565	Travelling & Conveyance	316107.00			
312184	Tax & License	410028.00			
0	Certific course Training	1420960.00			
0	Consortium fees	15000.00			
0	Gaja Cyclone Rel.fund	81519.00			
0	Kerala Flood Rel.fund	96801.00			
0	Medical Expenses	60042.00			
0	Mst.Scholarship	5565000.00			
34908245		151027528.38	134908245		1510275

BALANCE SHEET AS AT 31ST MARCH 2019

st year	LIABILITIES	Rs. P.	Last year	ASSETS	Rs. P
15931018	MOHAMED SATHAK TRUST - PARENT BODY				
	Balance in account	271242516.00	212097419	<u>FIXED ASSETS</u>	1965634
	Less: Excess of Exp.over Income	70543520.71	5734603	<u>RECEIVABLES</u>	59706
		200698995.29	7261027	<u>ADVANCES & DEPOSIT</u>	74290
12941345	<u>CURRENT LIABILITIES</u>	12781327.00	3779314	<u>CASH & BANK BAL:</u>	35172
28872363		213480322.29	228872363		2134803

(Handwritten signature)

PRINCIPAL
MOHAMED SATHAK A.J.COLLEGE OF ENGINEERING
 34, Rajiv Gandhi Road (OMR) Siruseri, IT Park
 Chennai-603 103.

Chartered Accountants
 Firm Regn. No: 065935

(Handwritten signature)
 (S. Musthaque Ahmed)
 Partner. M. No: 201665
 20/09/19