Specific Targeted Project
Project: TST3-CT-2003-506243
supported by the EUROPEAN COMMISSION

Integrated Standard Transportation Unit

Publishable Final Activity Report

ISTU / 506243

The ISTU STREP project has investigated developed and has demonstrated a cost effective integrated propulsion unit for individual self-driven two-container rail platform wagons for freight container transport between ports and cargo distribution centres. As a major component an integrated motor with all major propulsion features is a key investigation of the project.

Major objective was to design and/or specify on base of a practical driving cycle for two-container wagons such platform for terminal applications based on a speed speed of 12kM/H and a maximum speed up to 50 km/h. The project has optimised and designed the complete vehicle system, i.e. all electro-mechanical components, including a Diesel- electric power supply unit to provide an autonomous integrated electrical propulsion system.
In a follow up it is intended to intensify the control to come to an unmanned automatic piloted transport system, and to advance to an eco-efficient electrical power supply system for applicability in industrial dense areas where such systems are expected to reduce road traffic, pollution and noise based on hybrid technologies. For this a new programme or financing is expected to follow ISTU.

As a second target, the project integrated for the mentioned application all main propulsion components such as motor, power converter, cooling and embedded controllers in one unit. With this propulsion rated at 30 kVA we expect to create the basic drive component for the container platform with improved characteristics as reduced cost (by 30%), efficiency increase by 2% and system availability up to 98%, validated by a laboratory set up.

The project analysed the needs and application scenarios in harbours with related logistic centres. With the basic assumptions the targets for the drive requirements were set and the according engineering process started. To avoid critical interferences of the different involved partners and their tasks, we used to couple the drive with the wheels of the platform via a standard cardan although not standard in rail. But, via this we could proceed to simultaneous engineering while the cost targets were reached. The design of the vehicle and the propulsion could be done individually, optimizing the design on the different partners in the project.

A first prototype of the integrated Drive called IPMOT confirmed the technical features and revealed some improvement possibilities with regard to the overloading characteristics of such motor. In a further redesigned and completed product we integrated these features by smaller changes in the winding layout. Parallel the full vehicle was designed, a proper Diesel-Electric power supply unit chosen and all components integrated in the vehicle structure.

Additionally this drive have been analysed for road operation which is another even more demanded alternative from the market. The Engineering for a rail vehicle is actually validated in a test belt although the simulated results are demonstrating the targeted values already. Dissemination has been done on several conferences and will be expected in the World Cargo News. Technology is actually presented to different ports and has been demonstrated on the INNOTRANS fair in Berlin in 2006.

Project funded by the European Commission under the "Sustainable Development, Global Change and Ecosystem Programme" of the 6th Framework Programme,Key Action :Sustainable Transport Policies

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Integrated Standard Transportation Unit

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Acronym:	ISTU
Name of proposal:	Integrated Standard Transport Unit for self-guided freight container transportation systems on rail
Contract number:	506243
Instrument:	STP
Total cost:	1 397 165 €
EU contribution:	896 000 €
Call:	FP6-2002-Transport 1
Starting date:	01.11.2003
Ending date:	30.09.2006
Duration:	35 months
Sector:	Rail
Objective:	3
Research domain:	15
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Abstract

The ISTU STREP project investigates, develop and demonstrate a cost effective integrated propulsion unit and an individual self-driven two-container, cost improved rail platform wagons for freight container transport between ports and cargo distribution centres. The new motor concept integrating all major propulsion features is a key technology suited for the designed harbour vehicle called ISTU.

Background

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Integrated Standard Transportation Unit

The increasing transport of shipped containers request from modern harbour infrastructures eco-efficient, clean and quick logistic systems to discharge ships and send the cargo urgently to interim logistic centres where they can than be selected for final destination. More and more Automatic Guided Vehicles (AGVs) are under consideration as analysis of the last 10 years have shown their effectiveness and cost advantages. Today only some ports have been equipped with according systems still a manual driven operation is standard. Nevertheless AGVs are more and more in focus.

Still such systems are expensive and the pollution aspects with diesel driven vehicles high, increasing energy cost a further nail for operators. Since the signing of the Kyoto Protocol these 24 hour operating Diesel-engines in harbours, mostly located in the centre of cities are critically seen due to their polluting features.

This project considers an alternative technology for such AGV to overcome some of these major problems within a future generation. ISTU concentrate on the design and specification of a two-container wagon for terminal applications based on a speed up to 50 km/h with a Diesel- electric power supply unit to provide an autonomous integrated electrical propulsion system. The chosen technology can be extended to respond to all major future eco-efficient systems.

Objectives

Target is the design, marketing and validation of such container platform satisfying a practical driving cycle of two-container wagons within terminal applications including their requested security and application aspects. A major objective is to integrate for the mentioned application all main propulsion components such as motor, power converter, cooling and embedded controllers in one drive. With this propulsion rated at 30 kVA we expect to create the basic drive component for the container platform with improved characteristics as reduced cost (by 30%), efficiency increase by 2% and system availability up to 98%, validated by a laboratory set up.

As a technical goal the ISTU vehicle is designed for terminal application based on a standard speed of 12kM/H and a maximum speed up to 50 km/h. The ISTU project optimizes and designs the complete vehicle system, i.e. all electro-mechanical components, including a Diesel- electric power supply unit to provide an autonomous integrated electrical propulsion system.

The full vehicle integration is part of the project while the Engineering work will concentrate on the full documentation and the specification of all needed components, including the power supply in form of a cost effective Diesel/Generation set. The product will be evaluated as per its cost targets where we have set strong objectives for market acceptance.

Finally the market approach and the application is an objective of the project including security aspects for such systems in their environment and the dissemination on the market of the chosen technology.

Description of work

The project analyses the needs and application scenarios in harbors with related logistic centre's. With the basic assumptions the targets for the drive requirements were set and the according engineering process started. To avoid critical interferences of the different involved partners and their tasks, we used to couple the drive with the wheels of the platform via a cardan although not a standard today in rail technology. Via this approach we could proceed to simultaneous engineering while the cost targets were reached. The design of the vehicle and the propulsion could be done individually.

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Integrated Standard Transportation Unit

A first prototype of the Integrated Propulsion Motor Unit called "IPMOT" confirmed the technical features and revealed some improvement possibilities with regard to the overloading characteristics of such motor. In a further redesigned and completed product we integrated these features by smaller changes in the winding layout. Parallel the full vehicle was designed, a proper Diesel-Electric power supply unit chosen and all components integrated in the vehicle structure.

As an extension from this technology a road driven vehicle was additionally analyzed.

Results

To cope with the objectives we have chosen a simple switched reluctance 30 kW motor as base propulsion component. This motor and its components to be integrated have been dimensioned and the layout done for all the requested components of this integration process. Furthermore a brake system has been added on the shaft of the motor.
Within a redesign we have increased the overload capabilities considerably as to allow the integrated motor to be the main component within future hybrid drives. Additionally this drive has been analyzed for road operation which is an alternative market request. The Engineering for a rail vehicle is actually validated in a test belt although the simulated results are demonstrating the targeted values already.

Dissemination has been done on several conferences and will be expected in the World Cargo News. Technology is actually presented to different ports and will be demonstrated on a fair next. A follow up intends to intensify the work on a suitable logistic control to come to an unmanned automatic piloted transport system for eco-efficient electrical power supply system.
Extension to industrial dense areas where such systems are expected to reduce road traffic, pollution and noise is possible. ISTU is an official Trade Mark.

Keywords: Automatic Guided Vehicle, Integrated Propulsion, Eco-Efficiency

PARTNER

Order	Partner	Country
2	Aachen University of Technology	DE - Germany
3	Politechnico di Torino	IT - Italy
4	APS energia Sp. z o.o.	PL - Poland
5	Skoda Trakcny Motory s.r.o.	CZ - Czech Republic
7	Instytut Pojazdów Szynowych „TABOR”	PL - Poland

IMAGES

Filename	Caption	Copyright	Comment
IPMOTdrawing.jpg	Integrated Propulsion Motor Unit "IPMOT"	ITAPS GmbH	
ISTUplatform.jpg	ISTU Vehicle Rail Platform	ITAPS GmbH	

World cargo news info on July 2006

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New AGV concept

German company ITAPS (Innovative Trade and Product Strategies) has developed with different international partners from Industry and Research, a new AGV concept for road and rail applications that has potential for container terminals. ITAPS was set up to bring Polish and West-European companies together, to develop new ideas and products in various sectors including transport and logistics. In 2003 ITAPS received EU funding to "investigate, develop and demonstrate a cost effective integrated propulsion unit for individual self-driven container rail platform wagons for freight container transport between ports and cargo distribution centres".

The vehicle is called the ISTU® (Integrated Standard Transportation Unit) and is designed as an alternative to conventional locomotive-pulled freight for rail applications on rail, for drayage between cargo distribution centres and in port container yards as an AGV. A major part of the research project was to design drive components suited for hybrid application which is expected to be more cost and eco-efficient, fuel efficient and reliable than what is available today on the market. ITAPS MD Hans Bendien says the company has developed an integrated motor concept (IPMOT) that is similar to the once used in the latest hybrid cars but with high overloading capabilities. With this technology we expect to reduce the pollution in modern harbours. With our future hybrid concept and this motor, AGVs will overcome the inertia of a heavy load even with nearly half the power of today Diesel engines. The new electric propulsion concept has been developed based on switched reluctance motor technology – an AC motor with no windings or permanent magnets on the rotor which gives a high reliability to the product. With a 80…100 kW Engine a low-speed rail application, where the load on a two-axle ISTU® is limited by the 22.5t axle load, can be realised.

Initially developed as a rail-mounted vehicle, the ISTU® concept has been adapted for port applications as "road tired" product where the load can be heavier. It has a chassis weighing 12t and is designed to carry a 60t load (1x40' or 2x20' containers) at 10km/h. Maximum speed is 25km/h and acceleration with a 30t load is 0.3m/sec2. The braking system features disc brakes on each of the 2 drive motor shafts and a spring applied hydraulically released parking brake on each wheel.

Bendien says development of the integrated propulsion system is now complete and ITAPS is now looking for partners to develop the navigation and control systems. Within partnerships between ITAPS and companies from Poland and the Czech Republic the ISTUs and AGVs will be produced. The drive system has been demonstrated to European container terminals using AGVs and will be shown at the InnoTrans rail exhibition in Berlin this September.

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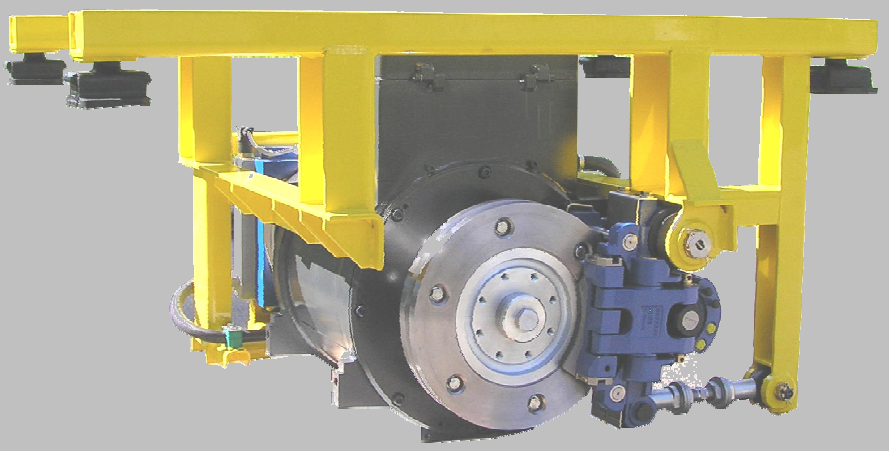
IPMOT - Integrated Propulsion Motor Unit



IPMOT - TECHNICAL DETAILS

IPMOT- is a first **"plug and play drive"** for traction application developed for rail and road application, automatic guided vehicles. The technology integrates the propulsion, power controllers, cooling and brake systems.

IPMOT means:

- Integration of electro-mechanical, cooling and control system
- Compact mechanical construction
- 5 pole supply system (2 electrical power supply, 2 cooling supply channels, 1 control signal)
- Efficiency up to 91%,
- Availability > 98%
- Reduction of: complexity, cost, interference liability

Traction machine

Traction motor type - 4-phase Switched Reluctance Machine
Nominal Torque T_n= 435 Nm at 517 rpm
Nominal Peak Phase Current I_{nPeak}= 105 A
Nominal RMS Phase Current I_{nRMS} = 63 A
Nominal Supply Voltage 400 V_{DC}
Nominal Output Power P_n ~35 kW
Maximum Rotational Speed 2590 rpm
Overloading Possibility 100%/2 min
Ambient Temperature 30 - 80°C

Control Unit

Fully controlled IGBT 4 - phase half bridge converter
Motor control unit - "Direct Average Torque Control (DATC)"

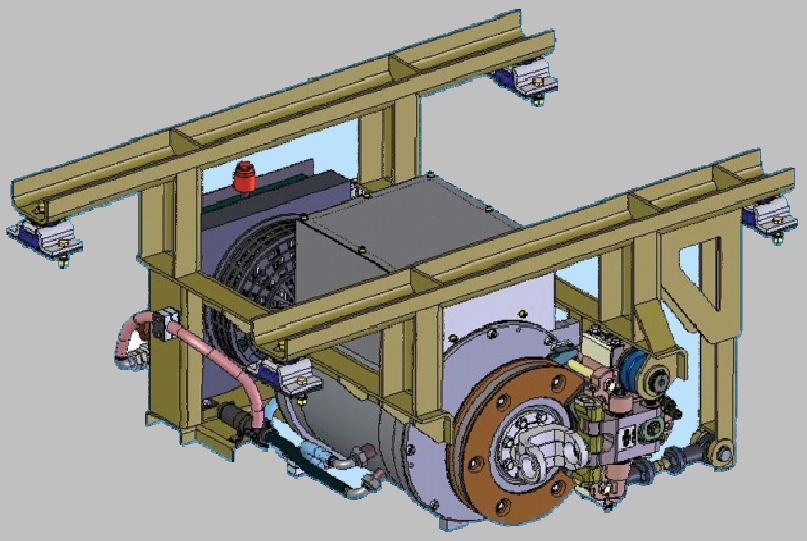
Cooling system

Cooler type LDC 011-B-C-50-000-P-0
Nominal work temperature- 60ºC
Cooling pump type - CM10P7-1
Pump supply voltage - 24 V_{DC}

Brake system

Brake disc - Knorr Bremse
Brake actuator - Knorr Bremse

IPMOT - Integrated Propulsion Motor Unit



SWITCHED RELUCTANCE MOTOR TECHNOLOGY

IPMOT - APPLICATIONS

SURS PASSENGER VEHICLE

ISTU FREIGHT RAIL PLATFORM

AUTOMATIC GUIDED VEHICLE

BUS VEHICLES

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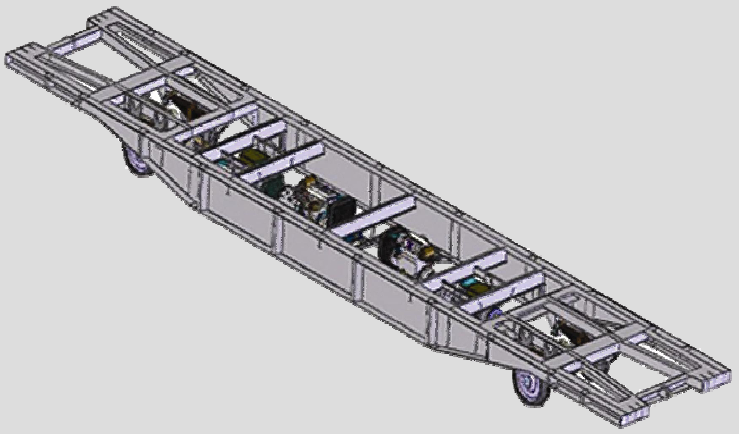
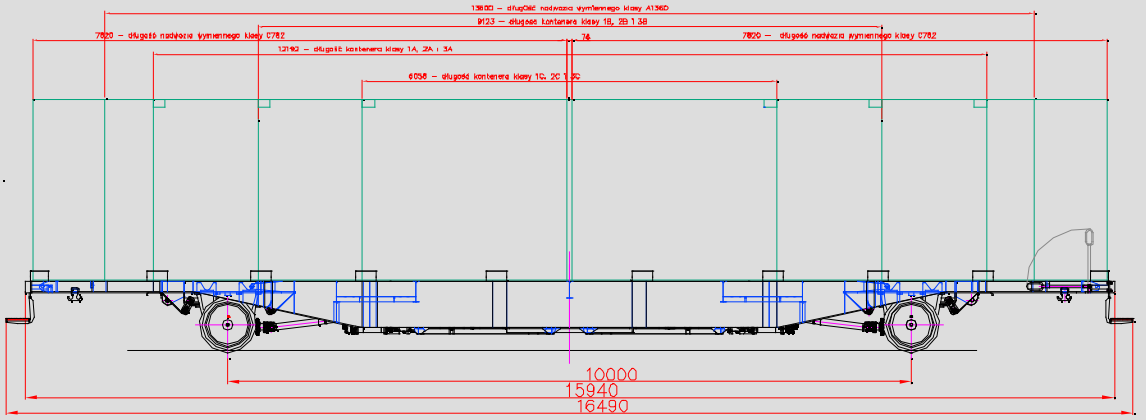
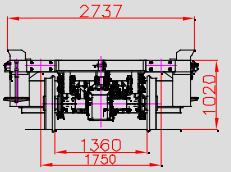
ISTU®-Integrated Standard Transportation Unit

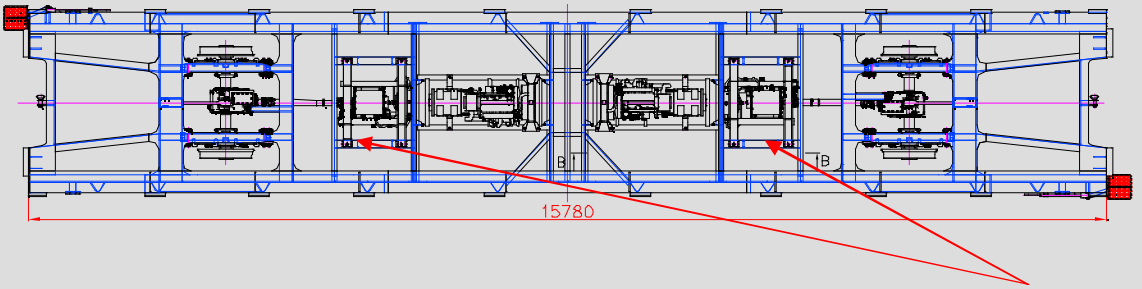


ISTU-technical specification

- Self-guided vehicle
- Total length 16400 mm
- Width 2737 mm
- Weight ca. 11,0 t
- Axle load 22,5 t
- Height of loading surface up 1020 mm
- Max loading 34,0 t
- Standard gauge of 1435 mm
- Wheel diameter 760 mm
- Loading and unloading by a typical loading equipment
- Max. speed 50 km/h
- Average speed with loading ca. 10 km/h
- Diesel-Generator set 2
- IPMOT drive 2





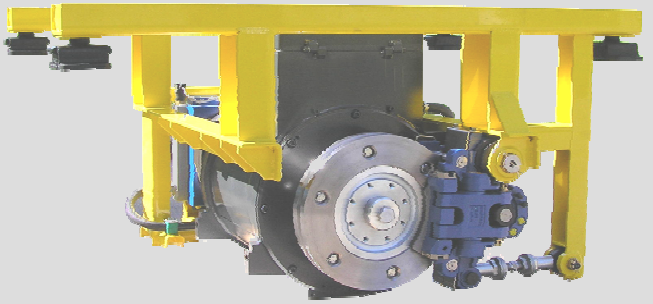


ISTU-load specification

- 1 container class A, B or C, of a gross weight of 34 t or
- 1 swap body class A, of a gross weight of 34 t or
- 1 swap body class C of a gross weight of 16 t or
- 2 swap bodies class C each of a gross weight of 16 t.

IPMOT

Integrated Propulsion Motor Unit fully integrated PLUG and PLAY drive solution



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