



TRANSGUN APPLICATION NOTE

700252A

EN6001 SERIES CONTROLS

MICROPROCESSOR BASED
Weld Sequence Controls
With
Solid State Thyristor Contactors

Wiring Diagram 421533-001 “D” Cabinet

Intended for use with firmware version 8.04 and higher

ENTRON
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1.0 GF – GROUND FAULT OPTION (HAND-HELD TRANSGUN)

The design of the optional GF (Ground Fault) circuit is meant to fulfill the recommended requirements of RWMA's Bulletin 5-015.68.04 (Figure 2.1) and AWS J1.1. (Figure 2.2) The recommended standard is typically called out to protect operators in hand-held transgun applications.

To understand the operation in more detail, see Wiring Diagram 421533-001 and the Weldsafe 5000 manual in Appendix A. Since CR1 (Weldsafe 5000) operation is discussed in Appendix A, its design will not be discussed further. The GF option monitors specifically the transformer load and the ground connection to it.

1.1 GROUND FAULT DETAILS

Weld transformer primary wires are passed through T5 (transformer/coil). Current will be summed by T5 and the difference sent to CR1. CR1 will monitor this current and will close a contact at the RWMA specification of 15 mA. These contacts pass 120 VAC, developed on the primary of PS1 (power supply 1), to the ST (shunt trip) on CB1 (circuit breaker 1). When the voltage is applied, the contacts of the breaker will open. Timing of this action will be within the RWMA recommendation of 60 ms.

A push-to-test circuit is composed of SW2 (push button switch 2) and R80 (10k resistor). When SW2 is closed, a current is developed from the primary voltage windings (120 VAC) of PS1, through R80 (approximately 20 mA), and is passed through T5.

1.2 GROUND DETECTOR

It is important that the control and gun be well grounded in the case of a high current fault to ground. This low impedance will allow properly designed upstream breakers to open before the voltage on the gun gets over 48 VAC. To insure a low resistance connection between the gun and control, CR1 (Weldsafe 5000) monitors the connection between the gun case and control ground via R82-2. The detect wire is routed from the gun case through the transgun cable to R82-2. From there, the signal is passed through SW4 and on to CR1. SW 4 is a push-to-test switch for the GND detection circuit. When pressed, R82 (1 ohm resistor) is inserted in series with this detect lead to perform the push-to-test feature.

When the CR1 measures 1 ohm or greater in the ground path, a separate set of contacts in CR1 relay will close. These contacts are in parallel with the EL and GF contacts and will pass 120 VAC from the primary windings of the Valve transformer to the ST of the CB1 and remove voltage to the control within 60 ms.

2.0 GF – GROUND FAULT OPTION (HAND-HELD TRANSGUN) (cont.)

RESISTANCE WELDER MANUFACTURERS' ASSOCIATION OCT. 1995

BULLETIN 5-015 SAFETY STANDARDS FOR CONSTRUCTION AND GUIDE FOR INSTALLATION AND OPERATION

BUL 5-015.68 GROUNDED CIRCUITS AND EQUIPMENT GROUNDING

.04 Special considerations for Portable Transguns

(a) *Portable Transguns* – shall be grounded per *Article 250 of the National Electrical Code* and require the use of (1),(2) and (3) listed below:

NOTE— Conduit or Raceways shall not be used as the grounding conductor.

NOTE— The intention of these requirements is to ensure that the grounding conductor to the transgun is sized correctly to allow sufficient ground fault current to flow for a time long enough to trip an upstream circuit breaker or other protection device. As a general guideline, the resistance of a grounding conductor should be maintained at a value to ensure the continuous and unrestricted flow of available ground fault short circuit current until the circuit protection device removes voltage from the equipment.

- (1) *Grounding Integrity* – The welding gun transformer case and secondary shall be grounded and protected by fail safe circuitry designed to immediately disconnect line voltage from the transgun via a circuit breaker with shunt trip or a circuit breaker with undervoltage trip. The combined clearing time shall not exceed 60 mS. A sensed value of grounding conductor resistance in excess of one ohm by the ground integrity monitor would be considered an inadequate ground [referred to in paragraph 5-015.68.04(a)(2)]. A push-to-test circuit providing a 1 ohm resistance between the sense lead and ground will be included to verify the operation of the ground integrity circuit.

NOTE— The ground integrity monitor operation shall not depend on a programmable device.

- (2) *Ground Fault Current Relay* – A sensitive, fail safe, ground fault relay with a maximum trip point of 15mA must be used to provide protection against differential ground fault leakage currents. The ground fault relay must immediately disconnect line voltage from the Portable Transgun via a circuit breaker with shunt trip or a circuit breaker with undervoltage trip. The combined clearing time shall not exceed 60 mS.

A push-to-test circuit supplying a test fault current, through the sense coil of 20mA maximum will be included to verify the operation of the ground fault relay.

Only three wires are allowed to pass through the ground fault relay current pickup transformer: two welding transformer primary conductors and the push-to-test circuit.

NOTE— The ground fault current relay operation shall not depend on a programmable device.

NOTE— If an Isolation Contactor is used, ground fault current will only be detected when this Isolation Contactor is closed.

NOTE— In (1) and (2) above, combined clearing time is the reaction time of the ground fault relay plus the clearing time of the shunt trip or undervoltage trip of circuit breaker.

- (3) *Ground shielded cable* – The weld transformer primary cable conductors between the weld control and the Portable Transgun must be surrounded by grounded shield. This shield must be tied to an appropriate ground lug at the control. In addition to the two primary conductors, ground conductor and shield, a ground sense wire must be included with the cable.

NOTE— The grounded shield provides a current path should a metallic component cut through the shield to a power conductor within the cable. This current path will then cause the ground fault current relay to trip.

Reproduced from RWMA Bulletin 5 – Resistance Welding Control Standards, October 1995.

Figure 2.1 *RWMA recommended standards for grounded circuits*

2.0 GF – GROUND FAULT OPTION (HAND-HELD TRANSGUN) (cont.)

AWS J1.1M/J1.1:2013 Specification for Resistance Welding Controls ANSI STANDARD

4.1.1 Manual Transgun Control

This control system employs additional devices necessary to ensure safe operation of manual transguns. Since the operating (line) voltage and ground wires connect to the transgun by means of a flexible power cable, supplemental systems within the welding control monitor the system for ground faults and ground circuit integrity. These supplemental systems provide an added level of operator protection in the event the ground connection is lost or there is an electrical

current leakage to ground. Such faults could indicate a component of the transgun is no longer adequately grounded or perhaps has become dangerously energized. A manual transgun control shall incorporate supplemental safety devices including a ground integrity monitor, ground fault detector, and a grounded-shield power cable.

4.1.1.1 Ground Integrity Monitor

A ground integrity monitor shall be provided in the manual transgun control system. This monitor senses the value of ground circuit resistance to identify conditions where there may be an inadequate bonding connection between the welding control and the transgun. In the event a fault is detected, the electrical supply shall be disconnected from the transgun in accordance with the performance specified in clause 7.9.1. A push-to-test circuit shall be included to enable verification of the ground integrity monitor operation.

4.1.1.2 Ground Fault Monitor

A sensitive, fail-safe, ground fault monitor shall be provided in the manual transgun control system. The earth-leakage detector, the most commonly applied system, uses a current coil surrounding supply and return conductors to detect differential current indicative of an undesired active path. In the event a fault is detected, the electrical supply shall be disconnected from the transgun in accordance with the performance specified in clause 7.9.2. The disconnecting means employed in 4.2.4.1 above also functions in this case. A push-to-test circuit supplying a test fault current, through the sense coil will be included to verify the operations of the ground fault monitor.

4.1.1.3 Grounded-Shield Power Cable

The weld transformer primary cable conductors between the weld control and the manual transgun shall be surrounded by a grounded conductive shield. This shield will provide a current path to ground within the cable should it be penetrated with something conductive. This shield shall be tied to an appropriate ground lug at the control. In addition to the two primary conductors, ground conductor and shield, a ground sense wire must be included within the cable to facilitate verification of the bonding connection between the resistance welding control and transformer.

Reproduced from **AWS J1.1M/J1.1:2013 Specification for Resistance Welding Controls**

Figure 2.2. AWS WELD CONTROL STANDARD

APPENDIX A WELDSAFE 5000 (cont.)



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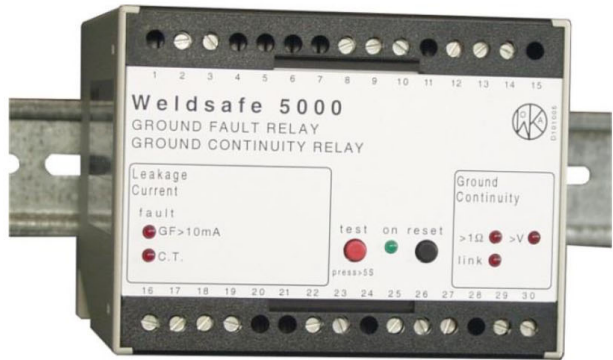
Fulder Tor 30, D-36304 Alsfeld • Phone: +49 (0)6631-776040 • Fax: +49 (0)6631-7760499 • Mail: info@woka-elektronik.com

WELDSAFE 5000

combination ground fault sensing and ground checking relay for AC 50-60 Hz applications
manual transgun applications

Features

- 10 mA trip point setting for ground fault sensing
- C.T. loop monitoring
- 1 ohm single trip point for ground checking
- Voltage Build-up Detection
- Optional End-of-Line Resistor for crush fault detection
- Harmonic filtering



The Welsafe 5000 combination ground fault current and ground check relay has been designed to provide sensitive ground fault protection and continuous ground checking for ac, 50-60 Hz manual transguns in accordance with RWMA Bulletin 5 standards.

Ground Fault Sensing Operation

The Welsafe 5000 protects operators and equipment from dangerous leakage currents that may occur when a circuit is energized. The device has harmonic filtering to prevent nuisance tripping and a pick-up response time of < 25ms.

Ground Fault Protection

The Welsafe 5000 ground fault function has two ground fault settings which will typically correspond to the size of the manual transgun. Setting 1 is the factory setting. This setting should always be used whenever practicable. Generally, Setting 1 will work for transguns smaller than 100 KVA. For manual guns larger than 100 KVA or with very high amperages (>40,000A), Setting 2 can be selected. All settings meet or exceed current RWMA recommendations. To determine which setting is correct, consult with your service operator.

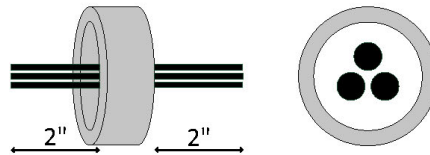
C.T. Loop Monitoring

The Welsafe 5000 also continuously monitors the connection to the current transformer to ensure proper functioning of the ground fault sensing. If this connection is broken, the unit will immediately operate.

CT600/.../WKE Series Current Transformers

The ground fault protection function of the Welsafe 5000 operates together with a CT600 series current transformer. There are different sizes available ranging from 1" to 5 1/8" depending upon the size of the load conductors passing through window. The C.T. is connected across terminals 16 and 17. Only the load carrying conductors pass through the C.T.. The ground wire must remain outside the C.T. core. It is also important that the cables

passing through the C.T. be as straight as possible (see diagram) to minimize the possibility of core saturation.



CT600/60/2 for High Current Applications

In applications where very high current is present, as in the case of a very large hand-held welding gun (>100KVA, 40,000A), this high current may influence the operation of the CT and cause nuisance tripping. The mounting and location of the CT within the control panel is very important. In order to get optimum results from the CT, it is recommended that the CT be mounted on the output side. This reduces the influence of any internal leakage caused by components in the welding control. For systems above 100 KVA, it is advisable to use either coaxial cable or order the CT600/60/2. This CT has been specifically designed with a 6" metal core insert and provides the same shielding from the high current as the coaxial cable.

Ground Checking Operation

The Welsafe 5000 has several protective methods to ensure proper grounding of fixed or portable equipment. If the unit senses any one of the following conditions, it activates the alarm relay (K2).

Subject to change!

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APPENDIX A WELDSAFE 5000 (cont.)



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manual transgun applications

Pilot Wire Ground Integrity Check

The Weldsafe 5000 monitors the resistance of the return path to ground via a ground connection from terminal 30 and a standard loop pilot wire going to the equipment from terminal 27. The unit continuously sends a measuring signal around the ground loop circuit. This circuit comprises the main equipment grounding conductor, a section of the equipment casing and a pilot conductor return path. When the Weldsafe 5000 detects a loop resistance in excess of 1 Ω , it will activate the output alarm relay (K2). The response time will vary depending upon the actual loop resistance value. The Weldsafe will react in < 30 ms for values approaching "open circuit" (see **table 1**).

Earth Voltage Build-up

The Weldsafe 5000 can also detect large ground fault currents that may cause unsafe voltage build-up on the ground path. If the unit senses a voltage >30 V ac on the ground path, it will immediately react to this condition.

Optional End-of-Line Resistor (EOL)

The Weldsafe 5000 ground checking operation has an additional protection feature. The unit can detect crush or parallel faults. This situation occurs when the cable ground wire becomes unintentionally connected to the equipment pilot wire. To sense this fault, a grounding resistor is connected at the end of the pilot wire from terminal 29. In this configuration, the Weldsafe 5000 will alarm if the ground wire ever comes into contact with the equipment pilot wire. This grounding resistor must have a value of 49.9 ohms with a high tolerance of +/- 0.1% to ensure proper function of the Weldsafe 5000. Circuit Savers can supply this resistor on request.

Please note: this end-of-line (EOL) will not affect the operation of the earth voltage build-up function.

Technical Information

Mounting and Wiring

The Weldsafe 5000 can be either DIN rail mounted (35mm) or screw-mounted by the 2 holes at the corners of the device. Terminals are clearly marked for connection.

Input Power Supply

The Weldsafe 5000 requires an auxiliary power supply of either 24Vdc, 24Vac, 120Vac or 230Vac 50-60 Hz. Customer must specify.

Trip/Alarm Output Relays

Two sets of changeover trip/alarm contacts (one for ground fault, one for ground check) are provided rated at 250 V, 5 A. These two relays can be set for tripping or remote indication. They can be configured for either failsafe or active operation, manual or auto reset. Factory settings are Failsafe and Auto Reset. To adjust relay for Failsafe/Active operation for either ground fault or ground check, open front cover. There is a small blue button in

the left and right lower areas. The switch on the left changes the ground fault, the one on the right changes the ground check. For Hand reset close contacts between 18-19, open for Auto.

LEDs

In addition to the trip relays there are six LED indicators on the front cover. The green LED indicates POWER ON. There are two red LEDs for the ground fault function:

- "GF" indicates leakage in excess of present trip level
- "C.T." indicates C.T. connection broken
- There are three LEDs indicating different conditions on the ground check function
- "1 Ω " indicates ground loop resistance in excess of 1 ohm
- "Link" indicates ground wire connected to pilot wire
- ">V" indicates voltage build-up in excess of 30 V AC

Test/Reset

The test facilities on the Weldsafe 5000 may be operated locally or remotely. They test both the ground fault sensing and the ground checking circuits. The test button, S1 is used to simulate a ground fault condition internally as a means of testing the relay function. An external test button can also be used to perform the same function test.

CT600 Current Transformers

CT600/25/WKE	1" internal diameter
CT600/60/WKE	2 1/3" internal diameter
CT600/95/WKE	3 3/4" internal diameter
CT600/130/WKE	5 1/8" internal diameter
CT600/60/2	2 1/3" internal diameter for high current applications, 6" metal insert

Power Supply Voltage Us	Order Number
DC24V	17007031
AC24V	17007041
AC120V	17007051

APPENDIX A WELDSAFE 5000 (cont.)



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WELDSAFE 5000

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manual transgun applications

Technical Data

Nominal AC insulation voltage 500 V ac
Insulation group to UL 1053
and VDE 0110(01.83) Dirty group 2
Test voltage 3000 V ac
Operation class Continuous
Input supply voltage ... 24V ac, 24V dc, 120V ac, 230V ac 50-60Hz
working range +/- 15%
Maximum self-consumption 10 VA
Alarm relay contacts Volt-free NO/NC
Switching capacity 1100 VA
Rated contact voltage 250V
Continuous current 5A
Breaking capacity
At: 240V ac, P.F.=0.4 3A
At: 110V dc, @L/R=0 0.3A
Adjustable function Failsafe/Active
Relay alarm memory Manual/Auto reset
Factory settings Failsafe/Auto
Operating ambient temperature -10° to +60° C
Storage ambient temperature -40° to +70° C

Mounting

Terminal M 2.5
Terminal capacity 0.5 to 4 mm²
Weight 575 g
Dimensions 2.96"H x 3.94"W x 4.33

Ground fault function

Trip level
Setting 1 factory setting
S8 closed 10 mA, +0%/-15%, ac 50-60 Hz
Response time 20–25 ms Response time
Setting 2
S8 open 10 mA, +0%/-15%, ac 50-60 Hz
Response time to current inverse time curve
..... see below
Current transformer CT600/.../WKE or CT600/60/2
Sizes 1" – 5 1/8" internal diameter

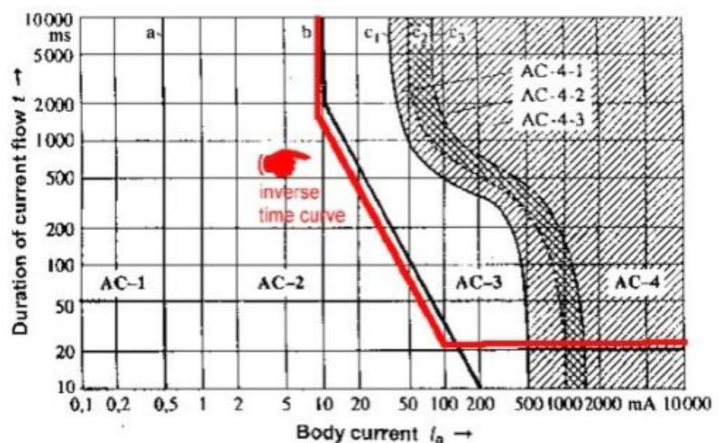
Ground check function

Loop resistance measuring current DC 20 mA
Trip Level 1 Ω , +/-15%
Stray voltage
(terminals 30-27 or 30-29) Max. 300 V ac (<5 sec)
Response time
0.5 Ω - open circuit < 30 ms
response time curve see table 1
Hysteresis Approx. 2%
Voltage response > 30 V ac

Industry Standards RWMA 5-015.68.04

Response Time for Ground Loop value change 0.5 Ω to R Ω	
0.5 Ω - 2 Ω	= 1.8 s
0.5 Ω - 5 Ω	= 1.8 s
0.5 Ω - 8 Ω	= 1.8 s
0.5 Ω - 10 Ω	= 1.8 s
0.5 Ω - 20 Ω	= 310 ms
0.5 Ω - 50 Ω	= 100 ms
0.5 Ω - 100 Ω	= 60 ms
0.5 Ω - 200 Ω	= 42 ms
0.5 Ω - Open	= 21 ms

Table 1



Weldsafe 5000 Ground Fault Setting 2 reaction time

APPENDIX A WELDSAFA 5000 (cont.)



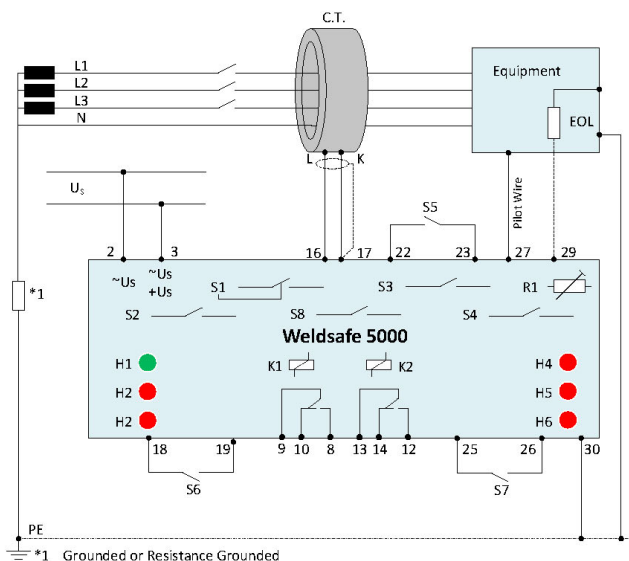
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WELDSAFA 5000

combination ground fault sensing and ground checking relay for AC 50-60 Hz applications
manual transgun applications

Connection Diagram E699001-2



PLEASE NOTE:

TO CHECK UNIT FUNCTION DURING COMMISSIONING, WE RECOMMEND TESTING THE WELDSAFA 5000 UNDER TRUE FAULT CONDITIONS. FOR THE GROUND FAULT FUNCTION, A SMALL RESISTOR, (e.g. 30 K Ω AT 480V) WILL GENERATE APPROX. 16 mA) CAN BE USED TO CREATE THIS CONDITION. FOR THE GROUND CHECKING FUNCTION, OPEN THE PILOT WIRE.

Legend

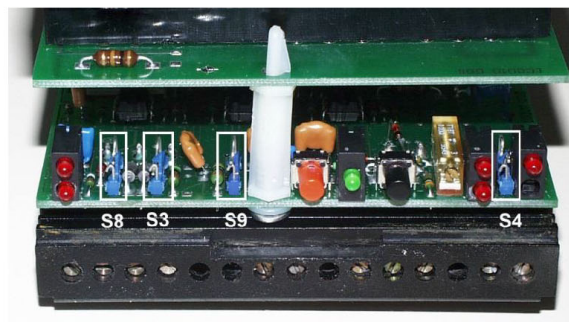
- H1 LED green POWER ON
- H2 LED red GROUND FAULT
- H3 LED red CT FAULT
- H4 LED red LOOP RESISTANCE > 1 Ω
- H5 LED red CRUSH FAULT
- H6 LED red VOLTAGE BUILD-UP
- K1 Ground fault alarm relay
- K2 Ground check alarm relay
- S1 Internal test button
- S2 Internal reset button
- S3 Switch for ground fault Failsafe/Active (behind front cover) Closed=active Open=failsafe
- S4 Switch for ground check Failsafe/Active (behind front cover) Closed=active Open=failsafe
- S5 External test button
- S6 External reset button for ground fault sensing
- S7 External reset button for ground checking
- S8 Trip level adjustment (behind front cover)
Closed = 10 mA fixed = factory setting
Open = 10 mA inverse response
- **R1 Loop resistance adjustment - see instructions

**R1 Loop Resistance Adjustment

This is an internal adjustment that must be made when cable length is very long and the loop resistance is high (0.5..0.8 Ω). Please check with manufacturer about your specific application.

Terminals

- 2-3 Input power supply
- 8-9-10 Contact for K1 alarm relay – ground fault
- 12-13-14 Contact for K2 alarm relay – ground check
- 16-17 C.T. connection
- 18-19 Ground fault external reset,
Hand=closed Auto=open
- 22-23 External test button (optional)
- 25-26 Ground check external reset,
Hand=closed Auto=open
- 27 Pilot wire if using standard ground check monitoring
- 29 Pilot wire if using EOL monitoring
- 30 Ground connection
- EOL End-of-line resistor, 49.9 Ω , +/-0.1

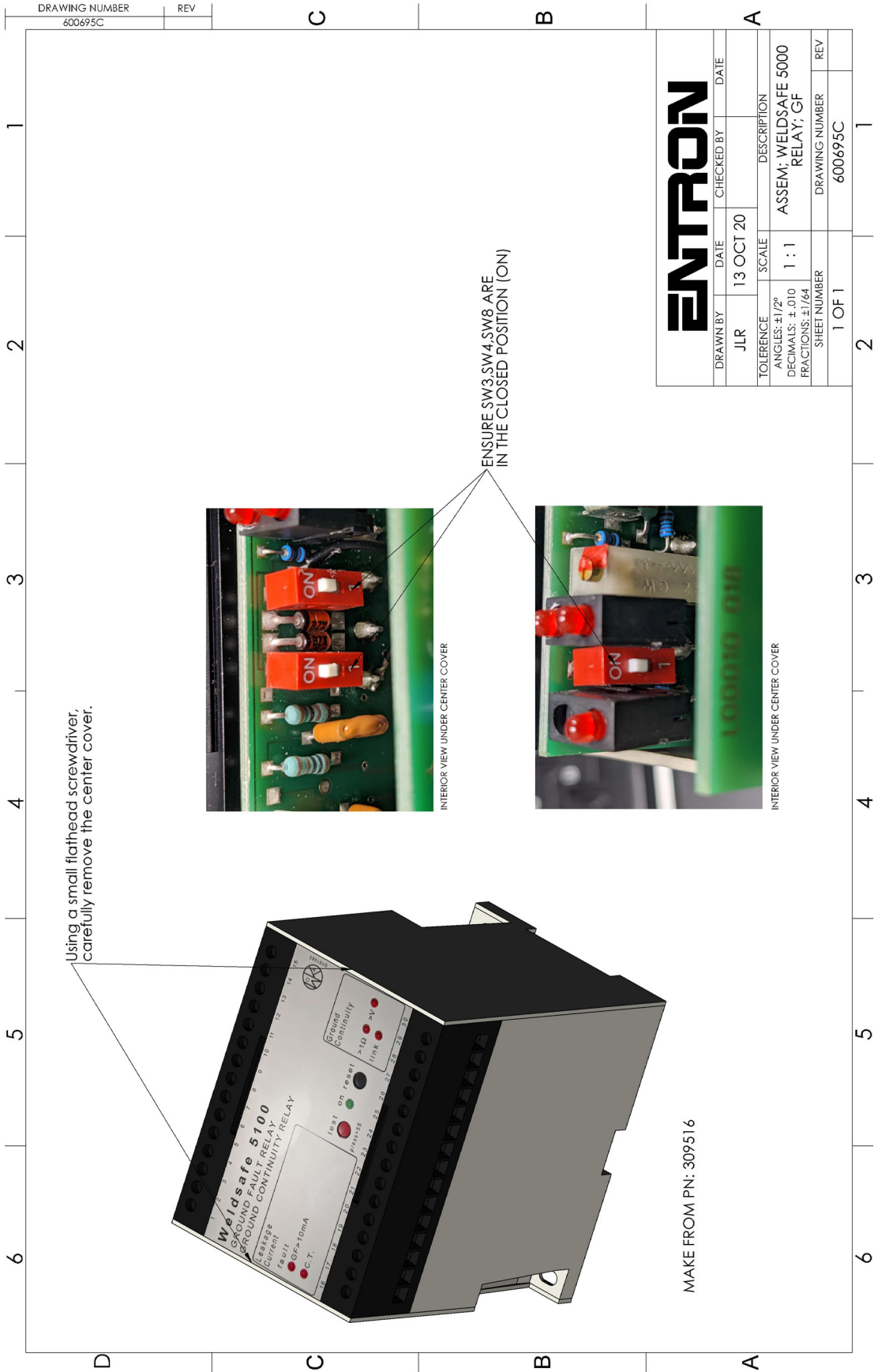


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APPENDIX B WELDSAFE 5000 (cont.) WELDSAFE 5000 MODIFICATION NOTES



APPENDIX C TRANSGUN MODEL NUMBER DEFINITIONS



APPLICATION NOTE 700204-001

TRANSGUN MODEL NUMBER DEFINITIONS

	A	B		C		D		E		F		G
EN	6001	(BLANK)	– 300D 1200D	/	GF	/	103 203		ST		ACV

NOTICE

This Application Note applies only to controls with operators using transguns. Non-hand-held guns can use standard non-GF (ground fault) controls.

- A.** Determine control type – **6001**. For EN6001.
- B.** Determine transgun type
BLANK – no connector; valve voltage and valve power supply to be called out in column **G**.
CES, ERG, PW, TGA are no longer manufactured. OEMs and end users can add specific connectors as needed.
- C.** Determine contactor and Cab. size – **300D** or **1200D**.
- D.** All transguns must have ground fault (**GF**).
- E.** Choose breaker
 1. First digit – choose **1** for 100 amp; choose **2** for 200 amp (100 or 200 amp only).
 2. Second digit – **0**
 3. Third digit – choose **3** for 3 pole for single phase guns.
- F.** All controls with **GF** need shunt trip (**ST**).
- G.** ACV Option for AC Valves when required. Adds AC Valve PCB and 150 VA Valve power supply with both 24 and 120 VAC outputs.

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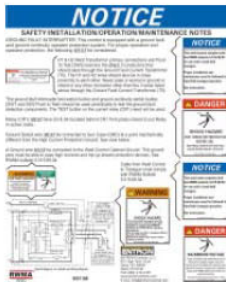
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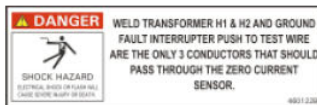
APPENDIX D RWMA PRECAUTIONARY LABELING

PRECAUTIONARY LABELS FOR TRANSGUNS

02/21/08



LABEL #: 460118B
SIZE: 8.0"W x 9.5"H
DESCRIPTION: GF SAFETY NOTICE
PLACEMENT: On interior of control on door of controls with Ground Fault protection
PURPOSE: To assist installers with installation of Ground Fault System
Compilation of 460122, 460198, 460343, 460344, 460348, 460349, 460350



LABEL #: 460122B
SIZE: 1.0"W x 3.0"H
DESCRIPTION: DANGER GF COIL
PLACEMENT: On exterior of GF coil
PURPOSE: To keep only the push to test wire and weld transformer wires as the only wires that go through this coil; otherwise GF detection may not work



LABEL #: 460144C
SIZE: 2.625"W x 3.25"H
DESCRIPTION: HAZARDOUS VOLTAGE GND/PE
PLACEMENT: On interior of control of weld controls at GROUND connection
PURPOSE: To advise control must be grounded and this is the point



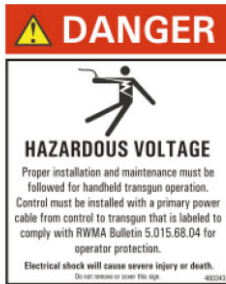
LABEL #: 460198B
SIZE: 2.625"W x 3.25"H
DESCRIPTION: SHOCK HAZARD TEST OPERATOR PROTECTION
PLACEMENT: On exterior of control on door near Push to Test switches on controls with Ground Fault detection and Earth Leakage Detection
PURPOSE: To advise to use Push to Test buttons regularly



LABEL #: 460281B
SIZE: 2.625"W x 3.25"H
DESCRIPTION: DO NOT DEFEAT OR REMOVE PROTECTION DEVICES
PLACEMENT: On interior of control near protection devices
PURPOSE: To assist Maintenance/Service personnel to not defeat protection devices

APPENDIX D RWMA PRECAUTIONARY LABELING (cont.)

PRECAUTIONARY LABELS FOR TRANSGUNS



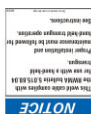
LABEL #: 460343
SIZE: 2.625"W x 3.25"H
DESCRIPTION: HAZARDOUS VOLTAGE TRANSGUN
PLACEMENT: On interior of control of controls with Ground Fault Detection
PURPOSE: To advise installer of proper installation requirements



LABEL #: 460344
SIZE: 2.625"W x 3.25"H
DESCRIPTION: NOTICE THIS WELD CONTROL...
PLACEMENT: On exterior of controls with Ground Fault
PURPOSE: To advise operator that weld control meets RWMA requirements



LABEL #: 460348
SIZE: 2.625"W x 8.5"H
DESCRIPTION: NOTICE THIS WELD CABLE...
PLACEMENT: On weld cables of transguns
PURPOSE: To advise operator that weld cable meets RWMA requirements



LABEL #: 460349
SIZE: 2.625"W x 3.25"H
DESCRIPTION: SHOCK HAZARD THIS HAND-HELD TRANSGUN...
PLACEMENT: On transgun
PURPOSE: To advise to use correct control and cable



LABEL #: 460350
SIZE: 9"W x 1.7"H
DESCRIPTION: VOLTAGE HAZARD GROUNDED DEVICE
PLACEMENT: On ground protection devices as some devices may not be understood to be such
PURPOSE: To advise maintenance personnel that this is a ground protection device

[illegible]

